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MEASURES OF LEARNING RATES FOR ELEMENTARY SCHOOL STUDENTS IN MATHEMATICS, AND READING UNDER A PROGRAM OF INDIVIDUALLY PRESCRIBED INSTRUCTION.

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THE CONSISTENCY OF THREE MEASURES OF LEARNING RATE IN MATHEMATICS AND READING WAS STUDIED OVER DIFFERENT UNITS OF STUDY. STUDENTS OF GRADES ONE THROUGH SIX (N=152) MATHEMATICS AND READING, INDIVIDUALLY PRESCRIBED INSTRUCTION. EACH WAS ASSIGNED TO A SPECIFIC LEVEL IN A CONTENT AREA BASED ON SUBJECT MASTERY. THE RATE MEASURES INCLUDED THE TOTAL NUMBER OF MATHEMATICS AND READING UNITS MASTERED BY A STUDENT, THE NUMBER OF DAYS A STUDENT REQUIRED TO MASTER A GIVEN UNIT, AND AN INDEX OF RATE OF LEARNING. THE RESULTS INDICATED THAT THE RATE OF STUDENT LEARNING, AS MEASURED, WAS SPECIFIC TO A GIVEN TASK, AND NOT A GENERAL FACTOR OPERATING UNIFORMLY IN ALL LEARNING SITUATIONS. NONCONSISTENT STUDENT-LEARNING RATE WAS FOUND BETWEEN THE CURRICULUM AREAS OF MATHEMATICS AND READING FOR THOSE RATE MEASURES PERTAINING TO SPECIFIC UNITS. FINALLY, THE LEVEL OF READING ACHIEVEMENT WAS NOT RELATED TO THE RATE OF LEARNING MEASURES FOR SPECIFIC UNITS. (RS)

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MEASURES OF LEARNING RATES FOR ELEMENTARY SCHOOL STUDENTS IN MATHEMATICS AND READING UNDER A PROGRAM OF INDIVIDUALLY PRESCRIBED INSTRUCTION

By

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FOREWORD

The research and development reported herein was performed pursuant to a contract with the United States Office of Education, Department of Health, Education and Welfare, under provisions of the Cooperative Research Program.

The writer would like to take this opportunity to express his deepest gratitude to his major advisor, Dr. C. M. Lindvall for the understanding, encouragement, and guidance he so generously provided throughout the writer's graduate program and in the development of this study. Sincere appreciation must be extended to the members of the doctoral committee, Dr. John O. Bolvin, Dr. Richard C. Cox, Dr. Paul M. Kjeldergaard, and Dr. Vernon C. Lingren, who so willingly gave of their time and efforts as the writer progressed through his graduate work and in the preparation of this study.

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II. SUMMARY OF TOPICS OFFERED AT EACH LEVEL IN THE IPI READING CURRICULUM 17

I. INTRODUCTION AND REVIEW OF RELATED RESEARCH

A concern that has been increasingly evident in educational theory and practice during recent years is for the development of instructional programs that make some provision for individual differences. One evidence of this concern is the increasing volume of professional literature pertaining to problems that are confronted in any program for individualized instruction. It is also evidenced in the development of a variety of plans for individualization such as those utilizing programmed instruction, ability grouping, independent study, team teaching, enrichment and remedial programs, and non-graded instructional plans.

This heightened activity in developing new methodologies and organizational plans is partly a result of an increased awareness of the wide range of inter- and intra-individual differences found in any classroom. Goodlad and Anderson,[1] in a comprehensive study of non-grading, summarize six generalizations concerning the student and the conventional graded system of instruction:

> 1. Children enter the first grade with a range of from three to four years in their readiness to profit from a "graded minimum essentials" concept of schooling.
>
> 2. This initial spread in abilities increases over the years so that it is approximately double this amount by the time children approach the end of the elementary school.
>
> 3. The achievement range among pupils begins to approximate the range in intellectual readiness to learn soon after first-grade children are exposed to reasonably normal school instruction.

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[1] John I. Goodlad and Robert H. Anderson, The Non-Graded Elementary School, Revised, New York: Harcourt, Brace and World, Inc., 1963, pp. 27-28.

4. Differing abilities, interests, and opportunities among children cause the range in certain specific attainments to surpass the range in general achievement.
5. Individual children's achievement patterns differ markedly from learning area to learning area.
6. By the time children reach the intermediate elementary grades, the range in intellectual readiness to learn and in most areas of achievement is as great as or greater than the number designating the grade level.

Cook and Clymer,[1] supporting these generalizations in their findings concerning elementary school children, state that the range of achievement in given grades follows rather regular patterns. If the two percent at each extreme of the distribution is eliminated, the range of ability represented by a class is two-thirds of the chronological age of the typical student in the grade.

These findings indicate the wide variability of student achievement that is typically found in the conventional-type classroom.

It also would be anticipated that variability would be evidenced in terms of student rate of progress. This particular aspect of the learning situation has to date received only limited attention. The variable, "rate of learning," has traditionally been studied in the laboratory since typical classroom procedures do not yield information concerning rate of student progress. Traditional methodologies have attempted to disregard individual rates of learning by structuring the learning situation into a series of common experiences that attempt to have all students progress at a common rate. It has only been since the recent advent of programmed instruction, the non-graded organizational plan, and individualized instructional programs that individualization in rates of progress has been facilitated. Many investigators have shown that students, when given the proper opportunity, do progress at varying rates. Bolvin[1] has reported that in an experimental elementary school of over 200 children, a wide variance in the number of units of mathematics and reading was found to exist when the students were permitted to work under an individualized program of instruction.

---

[1] Walter W. Cook and Theodore Clymer, "Acceleration and Retardation," NSSE Yearbook, Nelson B. Henry, (ed.), Individualized Instruction, (Chicago: University of Chicago Press, 1962), p. 188.

Suppes,[2] working with 40 first-grade students, with a mean intelligence quotient of 137, under an essentially individualized method of instruction, found a wide divergence in student learning in mathematics. Suppes states that the most significant aspect of this individualized treatment was the fantastic difference in rate of learning. At the end of the first four weeks of this program, the fastest student had covered 150 percent more material than was covered by the slowest student. In a study by Suppes and Crothers,[3] utilizing a heterogenous group of 38 first-grade students studying reading, results showed that the faster child needed 196 trials to reach the criterion while the slowest child required 2,500 trials.

Kalin,[4] in developing a programmed text in mathematics for superior fifth and sixth grade students, tested his mathematics program on an experimental and control group. His findings indicated that the experimental group consisting of 95 students achieved the same degree of mastery as the control group but completed the work in 20 percent less time.

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[1] John O. Bolvin, Paper presented to Board of Visitors Meeting, Learning Research and Development Center, University of Pittsburgh, April, 1965. (Mimeographed.)

[2] Patrick Suppes, "Modern Learning Theory and the Elementary School Curriculum," American Educational Research Journal, I: 2, 1964, p. 80.

[3] Ibid., pp. 81-82.

[4] Robert Kalin, "Development and Evaluation of a Programmed Text in an Advanced Mathematical Topic of Intellectually Superior Fifth and Sixth Grade Pupils," (unpublished Doctor's Dissertation, Florida State University, 1962).

These studies indicate that when the student is provided the opportunity to progress at a self-determined rate a wide variance in learning rates is found. It is of importance to note that this variance was evidenced under different methods of instruction and does not necessarily appear to be unique to a particular type of instruction. Also, in the studies by Suppes, Suppes and Crothers, and Kalin, the students were selected to include restricted range of intelligence and represented atypical groups in which large variances would not normally be hypothesized.

There have been relatively few studies undertaken to determine the characteristics of various measures of rate of learning, although a great deal of theorizing has been done. Cronbach[1] postulates that when several intellectual tasks are to be learned under the same instructional conditions there will be some consistency within the individual with respect to the time needed to reach the criterion. If the tasks lie in the same general field, this consistency will be much stronger. This hypothesis implies that the student's learning rate will vary depending on the nature of the instruction and the task. Carroll[2] goes somewhat further by stating that ". . . the rate of learning is specific to the learning task and it is not a general parameter that applies to all learning factors." Both of these statements indicate that the instructional process and the task are two dimensions of primary importance.

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[1] Lee J. Cronbach, "How Can Instruction be Adapted to Individual Differences?" Paper presented at the Conference on Learning and Individual Differences, University of Pittsburgh, April, 1965. (Mimeographed.)

[2] John B. Carroll, "Comments on Cronbach's Paper," Paper presented at the Conference on Learning and Individual Differences, University of Pittsburgh, April, 1965. (Mimeographed.)

One early study that tends to support these hypotheses was undertaken by Woodrow[1] who spent twenty years studying the concept of learning rate in the laboratory through the analysis of learning curves. These studies were carried out under controlled conditions and used the slope of the learning curve as an estimate of learning rate. His findings indicate that there exists no general factor acting as one of the determining conditions of rate of improvement in widely different types of performance. This conslusion holds whether rate of improvement is measured by absolute gain, the gain per unit of time at the point on the curve when the individual's gain is at its maximum, or relative gain, the same gain taken as a proportion of the individual's indicated ultimate score.

Although Woodrow's study supports the hypotheses of Cronbach and Carroll, that learning rate is specific to the task to be learned, there is little research utilizing other measures or indicators of rate of learning. Carroll[2] has proposed a learning model on the assumption that the individual will succeed in learning a given task to the extent that he spends the amount of time needed to learn the task. In this instance, the learning task is defined as "going from ignorance of some specific fact or concept to knowledge or understanding of it, or proceeding from incapability of performing some specific act to capability of performing it."

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[1] H. A. Woodrow, "Interrelations of Measures of Learning," The Journal of Psychology, X, 1940, pp. 71-72.

[2] John B. Carroll, "A Model for Learning," Teachers College Record, LXIV, 1963, pp. 723-733.

Time, as measured in this model, is not elapsed time but rather time actually spent in paying attention and trying to learn. There are certain factors, such as aptitude and quality of instruction, which determine how much time an individual needs to spend in order to learn the task. These factors may or may not be the same as or associated with those influencing how much time he spends in learning. Carroll summarizes his model by the equation:

$$\text{Degree of Learning} = F\left(\frac{\text{amount of time actually used}}{\text{time needed}}\right)$$

The main problem in utilizing Carroll's model is the difficulty in quantifying the necessary variables.

Most of the studies that have been undertaken use Ebel's[1] definition of time in obtaining measures of learning rate. This definition states:

> Rate is the measure of an individual's speed of performance on tasks of a particular type, stated either in terms of the number of units of work done in a given time or the number of units of time required to complete a given amount of work.

Unfortunately, there has been little work done to determine the reliability of these various measures of rate. The one study that considers the problem of reliability of a measure of rate was carried out by Gropper and Kress[2] in studying the effects of different patterns of pacing student work using programmed materials. In this study, two groups of eighth graders (N = 252 and 356) were administered two science programs of approximately 100 frames in length. One of the most striking findings of this study was the consistency of student pace or work rate from program to program. Rate, in this instance, was the amount of time needed to complete the program. A correlation of .80 was obtained between the rate measure for the two programs.

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[1] R. L. Ebel, Measuring Educational Achievement, (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1965), pp. 459-460.

[2] George L. Gropper and Gerald C. Kress, "Individualizing Instruction Through Pacing Procedures," Audiovisual Communication Review, XIII, (Spring, 1965), pp. 166-168.

While this specific study demonstrated a reliable measure of rate for the particular type of instruction and task involved, other measures have not yielded such reliable results. It should, therefore, be important to obtain reliability estimates pertaining to other measures of rate under different methods of instruction for a variety of specified tasks.

The determination of specific student characteristics that influence different measures of learning rates is of particular interest. One characteristic, that of the individual's intelligence quotient, has received a relatively large amount of attention. Woodrow,[1] in one of the most comprehensive studies undertaken, obtained results that indicated no relationship between rate of improvement and intelligence. Cox[2] reported that in a preliminary study of an individualized instruction project there was no apparent association between the student's intelligence and the number of days needed to complete a given unit of work. This study involved over 170 elementary school students working under an actual classroom condition in selected units of mathematics and reading. Similarly, Suppes,[3] in his work with elementary mathematics found little relationship between the relative rates of student progress and intelligence.

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[1] Woodrow, _op_. _cit_., pp. 49-73.

[2] Richard C. Cox, Paper presneted to Board of Visitors Meeting, Learning Research and Development Center, University of Pittsburgh, April, 1965. (Mimeographed.)

[3] Suppes, _op_. _cit_., pp. 81-82.

McPherson,[1] in summarizing studies using gain scores as measures of learning rates, found that correlations between gain scores on various learning tasks and measures of intelligence usually average close to zero.

In an investigation of learning ability by Jensen,[2] junior high school students classified as "educationally mentally retarded" and having Stanford Binet I.Q. scores from 50 to 75 were compared on a selective learning task with average I.Q. (scores from 90 to 110) and gifted I.Q. (scores above 135) children in the same school. The task consisted of learning by trial-and-error to associate five or six different stimuli, colored geometric forms, with five or six different responses. The responses in this study consisted of an array of push buttons. Jenson developed an index of learning that was used to indicate the student's rate of learning. This index can be interpreted as the percentage of maximal possible performance above the level of chance performance. His findings indicated that there were highly significant differences between the groups and that the student's rate of learning correlated with intelligence. This finding was in agreement with the findings of the Glaser, Reynolds, and Fullick[3] investigation that studied intensively the effects of programmed instruction under a variety of conditions with students in different grades. Their findings indicate, in general, that intelligence appears to be related to the pace with which the student works through the program.

---

[1] M. W. McPherson, "Learning and Mental Deficiency," American Journal of Mental Deficiency, LXII, 1958, pp. 870-877.

[2] Authur Jensen, "Learning Ability in Retarded, Average, and Gifted Children," John P. DeCecco (ed.), Educational Technology, (New York: Holt, Rinehart and Winston, 1964), p. 375.

[3] Robert Glaser, James H. Reynolds, and Margaret G. Fullick, Programmed Instruction in the Intact Classroom, Project No. 1342, Cooperative Research, U.S. Office of Education, (December, 1963), p. 25.

These findings of Jensen and the Glaser, Reynolds and Fullick study are in contradiction with those of Woodrow, Cox, McPherson, and Suppes. This discrepancy probably is the combined result of the interactions of the types of rate measures employed, tasks that were learned, and the instructional methods that were utilized.

The purpose of this study will be to investigate some of the qualities of various measures of rate of classroom learning. Obviously, this type of study can be pursued only in a classroom situation which permits pupils to proceed through a learning sequence at individual rates. This provision is an essential part of the program for Individually Prescribed Instruction--the instructional program in which this study was carried out.

This program of individualized instruction will permit the investigation of various types of rate measures such as days in unit, number of units completed in a given time period, and various indexes of learning rate. These rate measures can then be examined as to their consistency between units in the mathematics and reading sequences and their relationship to selected student characteristics. Also, attention can be focused on the relationship between rates in different tasks within and between the curriculums.

II. THE PROBLEM

To provide a clear formulation of the problem being studied this chapter presents the definitions of key concepts, a formal statement of the problem, and the hypotheses that will be investigated.

A. Definition of Terms

In order to reduce the degree of ambiguity that can exist in discussing the variables that are employed in this study the following definitions are stated:

Rate of Learning--Three definitions of rate are used in this study.

1) The number of units of work that a student completes within a period of one year.

2) The number of days a student requires to complete a given unit of work.

3) The average daily achievement of a student working on a particular unit of work as represented by the equation:

$$\text{Rate} = \frac{\text{100 percent - achievement on pre-test}}{\text{Number of days in unit}}$$

Individually Prescribed Instruction (IPI)--A specific program for the individualization of instruction in selected elementary school subjects, developed as a project of the Learning Research and Development Center in collaboration with the Baldwin-Whitehall schools and the staff of the Oakleaf Elementary School. This is described in detail in Chapter III, Section A.

Intelligence--Score obtained on the California Test of Mental Maturity.

Consistency--Three measures of consistency are used in this study.

1) The Pearson product-moment correlation between and within curriculum areas.

2) The F-test for determining the significance of the differences among individual students when rate measures are totaled over several units.

3) Hoyt's estimate of the reliability of a total measure using an analysis of variance approach.[1]

Reading Achievement--Grade equivelent scores obtained on the Metropolitan Achievement Test Battery in the area of reading comprehension. Grade equivalent scores were used instead of raw scores because of the different forms used for the various grade levels.

B. Statement of the Problem

The purpose of this study is to investigate the consistency over different units of study of three measures of rate of classroom learning in elementary school mathematics and reading, and to ascertain the relationship of these measures to selected student variables.

C. Hypotheses

1. There is no significant correlation between the number of mathematics units and the number of reading units a student completes in one year.

---

[1] Robert F. Thorndike, "Reliability," E. F. Lindquist, (ed.) Educational Measurement. Meansha, Wisconsin: George Banto Publishing Company, 1955, pp. 590-591.

2. There is no significant correlation between the total number of mathematic units completed in one year and student intelligence.

3. There is no significant correlation between the total number of reading units completed in one year and student intelligence.

4. There is no significant correlation between student intelligence and initial placement in the mathematics sequence.

5. There is no significant correlation between the initial placement in the reading sequence and student intelligence.

6. There is no significant correlation between the final level of attainment in mathematics and student intelligence.

7. There is no significant correlation between the final level of attainment in reading and student intelligence.

8. There is no significant correlation between student level of reading achievement and the number of mathematic units mastered a year's time.

9. There is no significant correlation between student level of reading achievement and the number of reading units mastered in a year's time.

The following hypotheses will be investigated in terms of the two rate measures (1) number of days to complete unit, and (2) the difference between the criterion and the pre-test score divided by the number of days to complete unit.

10. There is no significant correlation between student rate in different topics at the same level in mathematics.

11. There is no significant correlation between student rate in different topics at the same level in reading.

12. There is no significant correlation between student rate in the same topic at the different levels in mathematics.

13. There is no significant correlation between student rate in the same topic at different levels in reading.

14. There is no significant difference between students when total rate measures are obtained over several units in mathematics.

15. There is no significant difference between students when total rate measures are obtained over several units in reading.

16. There is no significant correlation between student rate in mathematics and reading.

17. There is no significant correlation between the rate in a given unit of mathematics and student intelligence.

18. There is no significant correlation between the rate in a given unit of reading and student intelligence.

19. There is no significant correlation between student level of reading achievement and rate of learning in units of reading.

20. There is no significant correlation between student level of reading achievement and rate of learning in units of mathematics.

21. There is no significant correlation between the student rate measures of (a) the number of days to complete unit, and (b) the difference between the criterion and the pre-test score divided by the number of days to complete unit in mathematics.

22. There is no significant correlation between the student rate measures of (a) the number of days to complete unit, and (b) the difference between the criterion and the pre-test score divided by the number of days to complete unit in reading.

III. DESIGN OF THE STUDY

A. Description of the Individually Prescribed Instruction Project

In September 1964 the Learning Research and Development Center at the University of Pittsburgh initiated the Individually Prescribed Instruction Project (IPI) in the Oakleaf Elementary School of the Baldwin-Whitehall school district in suburban Pittsburgh. The purpose of this project was to investigate the feasibility of developing a system of procedures for producing an educational environment which was highly responsive to differences among children.[1]

The procedures that resulted are based upon the following assumptions:[2]

1. One obvious way in which pupils differ is in the amount of time and practice that it takes to master given instructional objectives.

2. One important aspect of providing for individual differences is to arrange conditions so that each student can work through the sequence of instructional units at his own pace and with the amount of practice that he needs.

3. If a school has the proper types of study materials, elementary school pupils, working in a tutorial environment which emphasizes self-learning, can learn with a minimum amount of direct teacher instruction.

4. In working through a sequence of instructional units, no pupil should be permitted to start work on a new unit until he has acquired a specific minimum degree of mastery of the material in the units identified as prerequisite to it.

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[1] Robert Glaser, "Individualized Learning: Notes on a Rationale of a System of Individually Prescribed Instruction," University of Pittsburgh, 1965. (Mimeographed.)

[2] C. M. Lindvall and J. O. Bolvin, "The Project for Individually Prescribed Instruction," University of Pittsburgh, 1965. (Mimeographed.)

5. If pupils are to be permitted and encouraged to proceed at individual rates it is important for both the individual pupil and for the teacher that the program provides for frequent evaluations of pupil progress which can provide a basis for the development of individual instructional prescriptions.

6. Professionally trained teachers are employing themselves most productively when they are performing such tasks as instructing individual pupils in small groups, diagnosing pupil needs, and planning instructional programs rather than carrying out such clerical duties as keeping records, scoring, etc. The efficiency and economy of a school program can be increased by employing clerical help to relieve teachers of many non-teaching duties.

7. Each pupil can assume more responsibility for planning and carrying out his own program of study than is permitted in most classrooms.

8. Learning can be enhanced, both for the tutor, and the one being tutored, if pupils are permitted to help one another in certain ways.

The instructional process that was derived from these eight assumptions consisted of the following four stages: (1) the behavioral specification of educational goals, (2) the detailed assessment of the entering competencies of the learner, (3) guidance of the student from the point of his entering competencies to the behaviors which represent subject-matter mastery as defined by agreed-upon educational objectives, and (4) evaluation of the effectiveness of the instructional process and quality control of the educational attainment of each student.[1]

B. The Individually Prescribed Instruction Curriculum Sequence

In order to implement this method of instruction the staff of the Learning Research and Development Center developed a sequence of behaviorally stated objectives for the mathematics and reading curriculum for kindergarten through grade six. Materials were then selected to enable students to achieve mastery of each of the stated objectives. These materials were not obtained from any single source, but rather from a large number of sources identified through an intensive survey of existing materials. One criterion that influenced the selection of these materials, aside from the specific behaviors that they were to teach, was the extent that the materials could be utilized by the student in studying independently of the teacher's assistance.

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[1] Glaser, op. cit.

This procedure resulted in the selection of a variety of materials and learning experiences for each of the stated objectives. Whenever commercially prepared materials proved to be unavailable or inappropriate, the Center's staff and the teachers at the Oakleaf school prepared the required materials. By following this procedure materials were assembled that allowed for a maximum use of individual study but with some dependence on small group instruction, large group instruction, and individual tutoring by the teacher.

The students in grades one through six typically spent forty-five minutes each day in the study of mathematics and a similar amount of time in reading. These two subjects as well as certain units in science were taught under the IPI system, while the remaining subjects were taught through more conventional methods.

The Mathematics Curriculum. The IPI mathematics curriculum is organized in terms of topic areas and levels of complexity. This can be represented as in Figure I in which the topics such as Numeration, Place Value, Addition, etc. represent specific content areas which the student covers at successive levels of complexity (A, B, C, etc.). That is, the typical student studies each topic at level A and then moves on to cover them again at level B. Those units designated with an "X" were used in this study.

TOPICS	LEVELS						
	A	B	C	D	E	F	G
Numeration	X	X	X	X	X	X	X
Place Value			X	X	X	X	X
Addition	X	X	X	X	X	X	X
Subtraction			X	X	X	X	X
Multiplication				X	X	X	X
Division				X	X	X	X
Combination of Processes			X	X	X	X	X
Fraction			X	X	X	X	X
Money	X	X	X	X	X	X	
Time	X	X	X	X	X		
System of Measure		X	X	X	X		
Geometry	X	X	X	X	X		
Special Topics			X	X	X		

FIGURE I. SUMMARY OF TOPICS OFFERED AT EACH LEVEL IN THE IPI MATHEMATICS CURRICULUM

The Reading Curriculum. The IPI reading curriculum was structured in a manner similar to that of the mathematics curriculum. Figure II presents the various topics and levels of complexity of the reading curriculum. This particular study used only the levels E through K due to the nature of materials that were utilized in the initial levels of the reading sequence. An "X" represents those units that were used in this study.

TOPICS	LEVELS										
	A	B	C	D	E	F	G	H	I	J	K
Comprehension					X	X	X	X	X	X	
Visual and Auditory Discrimination					X						
Visual Discrimination						X					
Auditory Discrimination						X					
Structural Analysis					X	X	X	X	X	X	
Phonetic Analysis						X	X	X	X	X	
Dictionary Skills					X	X	X	X	X		

FIGURE II. SUMMARY OF TOPICS OFFERED AT EACH LEVEL IN THE IPI READING CURRICULUM

Organization by Units. Each curriculum sequence is divided into a number of units such as Level A-Numeration or Level C-Addition, in mathematics, or Level E-Comprehension or Level I-Structural Analysis in reading. A unit of work consists of a series of behaviorally stated objectives that have been sequenced in a given content area at a specified level of complexity. The mathematics curriculum contains sixty-four units of work with each unit being made up of from one to thirteen objectives. The reading curriculum has twenty-seven units of work with individual units consisting of from one to twenty-five objectives.

C. Instructional Procedure

At the beginning of the school year each student was given a series of placement tests in the areas of mathematics and reading. The purpose of these placement tests was to assess the student's entering behavior and determine the level at which he should begin work in each content area. Each student was then assigned to a specific level in each content area. In this manner both inter- and intra-individual differences in level of achievement were accounted for in the mathematics and reading curriculums.

The student was then assigned work in the lowest unit in the continuum in which he indicated lack of mastery. Prior to starting his study in a unit the student was given a unit pre-test that was constructed to evaluate the skills contained within that particular unit. The student's performance on this pre-test was then examined and as a result of this diagnosis a series of learning experiences uniquely suited to the individual's competencies was prescribed.

These learning experiences consisted, for the most part, of work pages or other instructional materials that had previously been identified. A particular prescription could contain enough materials to provide the student with work lasting from a single day to a week, depending on the student's ability, the type of units being studied, and the number of experiences prescribed.

The student would "fill" his prescription by first obtaining the prescribed material from the learning center, either by himself or with the assistance of a teacher's aide. He then worked independently, receiving teacher assistance when needed, or in large and small groups under the direction of a teacher. Upon completion of a given learning experience, a student presented his work to the teacher's aide who would grade his materials and record his achievement. As the student progresses through each set of experiences his achievement was recorded in terms of his performance on the lesson materials and the results of a series of curriculum-embedded tests.

When a student completed the work in a given unit (which would be made up of a series of sequential prescriptions) his record was analyzed and he was assigned a unit post-test or given a prescription for additional work in the same unit. If a student exhibited mastery of a unit on the basis of his score on the post-test, he was assigned to the next lowest unit in which lack of mastery had been evidenced. If however, he failed to demonstrate mastery on the post-test, his performance was carefully analyzed and he was assigned a new prescription for those skills within the unit that he had failed to master.

It is through this process of continual re-evaluation that a student was permitted to progress from one learning task to another at a rate commensurate with his needs and ability.

D. Measures of Rate of Learning

There are a variety of rate measures that could have been investigated, but this study was concerned with only three rather basic and simple measures. The first measure was the total number of mathematic and reading units mastered by the student during the school year. Although this was a rather obvious measure of learning rate, it does provide information concerning the student's progress over an extended period of time. The primary limitation in using this type of measure was that the units being studied were not of equal complexity or length.

In order to partially compensate for this problem of unequal complexity or length of the units, a second measure was studied consisting of the number of days a student required to master a given unit. This measure represented a more refined measure of learning rate in that it considered only the amount of time a student spent on a given unit. A major limitation of this measure was that it did not take into account the student's knowledge of the material before starting to work in the unit.

Because of this limitation, a third measure was studied that consisted of an index of rate of learning. To obtain an index of student rate of learning for a particular unit of work the pre-test score was subtracted from one hundred and divided by the number of days spent in the unit. The index, therefore, represented the student's average daily achievement for a given unit of work. This measure considered the amount of content a student mastered in a unit and partially controlled for the student's entering behavior. One hundred was selected as the criterion because when a student was assigned a particular prescription, this prescription theoretically contained a sufficient number of learning experiences for the student to obtain one hundred percent mastery.

E. Research Population

The Individually Prescribed Instruction Project is being carried out in the Baldwin-Whitehall School District. This district serves a rapidly growing suburban area located south of the City of Pittsburgh consisting of a middle class residential area with a population of approximately 53,000 people.

The School district with a student population of approximately 8,500 students, maintains eleven elementary buildings, two junior schools, and one senior high school. The district employs over 400 professional staff members who are involved in teaching, administration, supervision, or assist in other ways in the district's educational program.

The research population that was used consisted of students in grades 1-6 at the Oakleaf Elementary School. The school employed during the 1964-65 school year a professional staff of 10 teachers and a clerical staff of 12 teacher aides.

A breakdown by grade of the number of students participating in this study is shown in Table 1.

TABLE 1

NUMBER OF STUDENTS PER GRADE

GRADE	1	2	3	4	5	6	TOTAL
Number of Students	27	26	30	26	21	23	152

F. Statistical Procedures

The statistical analyses contained in this study were such as (1) to provide information concerning the reliability or consistency of each of the three measures of learning rate, and (2) to provide information concerning the relationship of these measures to such student characteristics as intelligence and reading ability. To obtain this information and permit a comparision of th three measures on these qualities, the following analyses were made:

1. The correlation between rate measures for various subjects or sub-areas within a subject were computed in connection with each measure. This provided an index of the consistency of the measure over different subjects or units.

2. Where possible, namely with the second and third measures of rate, consistency was further studied through the use of analysis of variance. This involved testing the significance of differences among students in rate measures obtained over several units of study. This analysis also provided for the determination of the reliability of total rate measures obtained over several units through the use of the procedures suggested by Hoyt.[1]

3. Each of the three rate measures were further studied by determining the correlation between such measures obtained over a number of units of instruction and the student characteristics of intelligence and reading ability.

The correlational analysis was processed on the IBM 7090 computer at the Computation and Data Processing Center of the University of Pittsburgh. The computer program used in this study was a "Missing Data Correlation" program by Dr. Paul M. Kjeldergaard that provided for the matching of variable one with variable two and using only those cases where data were present for both variables.

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[1] Robert F. Thorndike, "Reliability," E. F. Lindquist, (ed.) Educational Measurement. Meansha, Wisconsin: George Banto Publishing Company, 1955, pp. 590-591.

IV. PRESENTATION OF DATA

The primary purpose of this investigation has been to study the reliability or consistency of each of three measures of student rate of learning and to determine the relationship of these measures to the student variables of intelligence and level of reading achievement.

This chapter will discuss each of the rate measures separately in terms of their consistency and their relationship to the student variables of intelligence and level of reading achievement.

A. Number of Units Completed in a Period of One Year

Initially the consistency of this rate measure was examined by determining the correlation between the number of mathematics units and number of reading units a student completed during one year of study. As indicated by the correlation of +.31 in Table 2, there is a significant relationship between the number of mathematic units a student completes and the number of reading units he completes over a period of one year. However, the association between these two variables is not strong. This coefficient when interpreted as a measure of consistency between student rate in mathematics and reading indicates the existence of a relatively minor degree of consistency.

This study then investigated the relationship between the rate measure, number of units completed, and the student characteristics of intelligence and level of reading achievement. The relationship that exists between this rate measure, when used with units of mathematics and reading, and student intelligence is shown in Table 3.

TABLE 2

CORRELATION BETWEEN TOTAL NUMBER OF MATHEMATICS AND READING UNITS COMPLETED IN ONE YEAR

VARIABLES	N	r
Total Mathematic Units and Total Reading Units	117	+.31**

**Significant at the .01 level

TABLE 3

CORRELATION OF STUDENT INTELLIGENCE WITH TOTAL NUMBER OF MATHEMATICS AND READING UNITS COMPLETED IN ONE YEAR

VARIABLES	N	r
Intelligence and Number of Mathematic Units	152	+.28**
Intelligence and Number of Reading Units	117	+.09

**Significant at the .01 level

As indicated by the Pearson product-moment correlation, r = +.28, a small positive relationship exists between student intelligence and the number of mathematics units a student masters in a period of one year. However, the correlation of +.09 indicates that there is no relationship between the number of reading units completed and student intelligence.

The significant relationship found to exist between the number of mathematics units completed and student intelligence could be attributed to the more clearly sequenced nature of the objectives found in the mathematics curriculum. The objectives and instructional units that constituted the reading curriculum at the time this study was conducted were not as rigorously sequenced nor as clearly defined as the mathematics units and hence yielded what was probably a poorer and less reliable measure.

This relationship of student intelligence and rate was explored by examining the correlation between student intelligence and level of initial and final placement in the mathematics and reading curriculum sequence. The student's initial placement was determined by the number of units he had mastered as indicated by his performance on a series of placement tests. All units in the curriculum sequence that were prerequisite to these units were counted as having been mastered. The correlation coefficients between student intelligence and initial placement in the mathematics and reading sequence are presented in Table 4 and 5 respectively.

TABLE 4

CORRELATION OF STUDENT INTELLIGENCE WITH LEVEL OF INITIAL PLACEMENT IN MATHEMATICS FOR EACH GRADE LEVEL

GRADE LEVEL	N	r
1	27	+.40*
2	26	+.42*
3	30	+.39*
4	26	+.58**
5	21	+.50*
6	22	+.81**

*Significant at the .05 level
**Significant at the .01 level

The date presented in Table 4 indicate an increasing relationship between intelligence and initial placement, ranging from r = +.39 to r = +.81, with increase in grade level. All of these correlations are significantly different from zero at least at the .05 level with those for grades four and six being significant at the .01 level. This would indicate that a moderately strong relationship does exist between student intelligence and initial placement in mathematics.

As shown in Table 5, a similar relationship holds for student intelligence and initial placement in the reading sequence as demonstrated by correlation coefficients ranging from +.33 to +.67. This would indicate a moderately strong relationship between student intelligence and initial placement in the reading sequence. The correlation coefficients for grades 1, 2, and 3 are not presented in Table 5 because the materials utilized by these students did not permit the obtaining of rate measures in terms of number of units mastered.

TABLE 5

CORRELATION OF STUDENT INTELLIGENCE WITH LEVEL OF INITIAL PLACEMENT IN READING FOR EACH GRADE LEVEL

GRADE LEVEL	N	r
4	26	+.49*
5	21	+.33
6	22	+.67**

*Significant at the .05 level
**Significant at the .01 level

Both Tables 4 and 5 indicate that there is an increase in correlation between initial placement in the mathematics and reading sequence and intelligence with increase in grade level. This increase in relationship is possibly due to the more restricted ranges found in the lower grades than those in the higher grades. The grade levels used in this analysis were based upon conventional classification procedures and not in terms of achievement. This means that "sixth grade" students could be working on materials ranging from third to seventh grade in terms of achievement.

In a like manner the relationship between student intelligence and final level of placement in the mathematics and reading sequences at the end of one year were studied. Tables 6 and 7 present the Pearson product-moment correlation coefficients obtained in these analyses. As indicated in Table 6, there is a substantial relationship between student intelligence and final attainment in the mathematics sequence. All but one of the six correlations for the various grade levels are significant at the .01 level and the correlation for grade five, +.52 is significant at the .05 level. Table 7 also demonstrates that a moderately strong relationship exists between student intelligence and the student's final placement in the reading sequence. This is particularly evident at the sixth grade level where a correlation of +.87 was obtained. These results indicate that a moderately strong relationship does exist between student intelligence and the final level of attainment in the mathematics and reading sequence.

TABLE 6

CORRELATION OF STUDENT INTELLIGENCE WITH FINAL LEVEL OF ATTAINMENT IN MATHEMATICS FOR EACH GRADE LEVEL

GRADE LEVEL	N	r
1	27	+.54**
2	26	+.55**
3	30	+.57**
4	26	+.69**
5	21	+.52*
6	22	+.88**

*Significant at the .05 level
**Significant at the .01 level

Again, as with those correlation coefficients resulting between intelligence and initial placement by grade level, there is an increasing trend in the correlation coefficients between intelligence and final placement in the mathematics and reading curriculum with increasing grade level. This is probably a function of the range of each grade level. Those at the lower grade levels having a much smaller range than those at the upper grade levels.

TABLE 7

CORRELATION OF STUDENT INTELLIGENCE WITH FINAL LEVEL OF ATTAINMENT IN READING FOR EACH GRADE LEVEL

GRADE LEVEL	N	r
4	26	+.53**
5	21	+.55*
6	22	+.87**

*Significant at the .05 level
**Significant at the .01 level

When number of units were used as a measure of student initial and final placement, there was a moderate relationship between these variables and student intelligence. However, this relationship was not found between the rate of learning measures, number of units completed in one year and student intelligence. It is difficult to explain the reason for this but one possible explanation would be that when using the rate measure, number of units completed in one year of study, each student worked in only those units where he evidenced difficulty. This means that each student was working at a level of difficulty commensurate with his ability and it would be anticipated that there would be little relation between intelligence and rate of work.

A second student variable that was investigated with respect to its relationship to rate of learning was level of reading achievement measured in terms of a grade equivalent score on the Metropolitan Achievement Test.

This variable, level of reading achievement, was selected for study because in the Individually Prescribed Instruction procedure most of the learning experiences that were assigned require that a student be able to read and comprehend both the directions and the material presented. Consequently, reading can be considered an aptitude necessary for IPI study. Table 8 shows the Pearson product-moment correlation coefficients that were obtained when the student's reading level was correlated with the number of mathematics and reading units completed during a period of one year. When rate in mathematics is correlated with level of reading achievement, a correlation of +.42 is obtained which is significantly different from zero at the .01 level. However, a correlation of only +.18, which is not significant, results when the number of reading units mastered is correlated with student reading level.

TABLE 8

CORRELATION OF STUDENT READING ACHIEVEMENT WITH THE NUMBER OF READING UNITS COMPLETED IN ONE YEAR

VARIABLES	N	r
Level of Reading Achievement and Number of Mathematic Units	128	+.42**
Level of Reading Achievement and Number of Reading Units	95	+.18

**Significant at the .01 level

The higher correlation of reading achievement with rate of progress in mathematics than in rate of progress in reading seem contradictory to what is expected, but does suggest that reading ability may be a factor in how rapidly a person can proceed through the mathematics sequence.

B. The Number of Days Required to Complete a Unit of Study

The second rate measure that was investigated was the number of days a student required to master a specific unit of work in the mathematics or reading curriculum. The use of this measure represents one way of avoiding the problem of the varying difficulty of the units, a problem which is present when gross number of units completed in a year is used as a measure. In studying this measure of rate of learning, only those units were selected for analysis that had been mastered by twenty or more students during the school year.

Of particular interest to this study is the consistency of this measure of rate of learning. Because of the structure of the curriculum sequence, the consistency of this rate measure, number of days to master a unit, will be examined in the following contexts: (1) the consistency between this measure of learning rate in different topics within the same level of work, (2) the consistency of the measure of learning rate in the same topic at different levels, (3) the consistency of this measure of student learning rate over three or more units of work. (4) the consistency of rate of student learning between units in mathematics and reading.

In analyzing the first situation, consistency of this learning rate measure between topics within a given level, Pearson product-moment correlation coefficients were computed for units in the mathematics and reading sequences. Table 9 presents the resulting coefficients that were obtained for levels C, D, and E in mathematics. There were few correlations that were significantly different from zero and those accounted for only a small proportion of the variance. As is evident from examining this table, there is, in general, no consistency between topics within a given level of mathematics.

TABLE 9

CORRELATION BETWEEN THE TIME SPENT IN DIFFERENT TOPICS AT THE SAME LEVEL IN MATHEMATICS

UNITS	N	r
C-Numeration and C-Place Value	39	+.28
C-Numeration and C-Subtraction	25	+.29
C-Numeration and C-Combination of Processes	24	-.36
C-Place Value and C-Addition	49	+.04
C-Place Value and C-Subtraction	54	+.13
C-Place Value and C-Combination of Processes	58	+.24
C-Place Value and C-Fractions	36	+.28
C-Place Value and C-Money	21	-.26
C-Place Value and C-System of Measure	34	-.26
C-Place Value and C-Special Topics	34	-.02
C-Addition and C-Subtraction	49	-.23
C-Addition and C-Combination of Processes	48	+.07
C-Addition and C-Fractions	33	+.38*
C-Addition and C-System of Measure	33	+.00
C-Addition and C-Special Topics	34	+.12
C-Subtraction and C-Combination of Processes	54	-.22
C-Subtraction and C-Fractions	33	+.09
C-Subtraction and C-Money	22	-.21
C-Subtraction and C-System of Measure	34	-.36*
C-Subtraction and C-Special Topics	35	-.35*
C-Combination of Processes and C-Fractions	38	+.30
C-Combination of Processes and C-Money	21	-.12
C-Combination of Processes and C-System of Measure	35	-.21
C-Combination of Processes and C-Special Topics	37	+.34*
C-Fractions and C-System of Measure	28	-.29
C-Fractions and C-Special Topics	27	+.43*
C-System of Measure and C-Special Topics	31	+.14

TABLE 9 (continued)

CORRELATION BETWEEN THE TIME SPENT IN DIFFERENT TOPICS AT THE SAME LEVEL IN MATHEMATICS

UNITS	N	r
D-Numeration and D-Place Value	35	+.37*
D-Numeration and D-Addition	36	-.23
D-Numeration and D-Subtraction	31	+.07
D-Numeration and D-Multiplication	21	-.19
D-Place Value and D-Addition	42	-.17
D-Place Value and D-Subtraction	36	-.29
D-Place Value and D-Multiplication	30	-.13
D-Place Value and D-Division	22	-.13
D-Addition and D-Subtraction	44	+.21
D-Addition and D-Multiplication	35	+.24
D-Addition and D-Division	30	+.01
D-Addition and D-Combination of Processes	23	+.08
D-Addition and D-Fractions	27	-.17
D-Subtraction and D-Multiplication	33	-.17
D-Subtraction and D-Division	30	-.21
D-Subtraction and D-Combination of Processes	29	-.17
D-Subtraction and D-Fractions	31	-.10
D-Subtraction and D-Money	20	+.00
D-Multiplication and D-Division	27	+.22
D-Multiplication and D-Combination of Processes	21	-.33
D-Multiplication and D-Fractions	25	+.01
D-Division and D-Combination of Processes	26	-.07
D-Division and D-Fractions	30	+.23
D-Division and D-Money	21	-.37
D-Combination of Processes and D-Fractions	31	-.05
D-Combination of Processes and D-Time	20	-.27
D-Combination of Processes and D-System of Measure	23	-.03
D-Combination of Processes and D-Geometry	22	+.10
D-Fraction and D-Money	29	+.09
D-Fraction and D-Time	35	+.18
D-Fraction and D-System of Measure	34	+.15
D-Fraction and D-Geometry	34	+.08
D-Fraction and D-Special Topics	27	-.21
D-Time and D-System of Measure	33	+.28
D-Time and D-Geometry	30	+.23
D-Time and D-Special Topics	20	-.40
D-System of Measure and D-Geometry	31	-.07
D-System of Measure and D-Special Topics	24	-.27
D-Geometry and D-Special Topics	22	-.00
E-Numeration and E-Place Value	24	-.11
E-Place Value and E-Multiplication	32	+.02
E-Place Value and E-Combination of Processes	20	-.01
E-Multiplication and D-Division	23	-.18
E-Multiplication and E-Combination of Processes	21	-.03

*Significant at the .05 level

An examination of Table 10 indicates that similar results are obtained when rate measures for topics within a given level in reading are correlated. These correlation coefficients range from a -.34 to a +.89, with two coefficients, G-Structural Analysis and G-Phonetic Analysis and H-Structural Analysis and H-Dictionary Skills, differing significantly from zero at the .01 level and two at the .05 level, F-Visual Discrimination and F-Phonetic Analysis, and G-Phonetic Analysis and G-Dictionary Skills.

The very large and significant correlations between G-Structural Analysis and G-Phonetic Analysis (+.89) and H-Structural Analysis and H-Dictionary Skills (+.72) have implications in terms of curriculum assessment. An examination of these particular units suggests that certain factors are common to all. The first of these is that there is a paucity of materials from which the teacher can select learning experiences to assign to pupils. In addition, these materials, for the most part, require that a mixed set of skills be performed instead of only the specific skill which the exercise was designed to teach. These conditions appear to result in the assigning of prescriptions that allow for only a minimum amount of individualization. This relative uniformity in the prescriptions assigned to all students may mean that shear working speed is the essential factor making for variation in progress in the paired units. With the present study this explanation, of course, must be largely conjecture, but it does suggest the importance of follow-up studies involving some procedure for more careful control of the prescription-writing process.

In view of the small number of coefficients that are indicative of a strong relationship, in general it can be concluded that there is no relationship between different units at the same level in mathematics or reading. These few significant coefficients could have occurred by chance in recognition of the large number of correlation coefficients computed.

TABLE 10

CORRELATION BETWEEN THE TIME SPENT ON DIFFERENT TOPICS AT THE SAME LEVEL IN READING

UNITS	N	r
E-Comprehension and E-Visual and Auditory Discrimination	22	-.12
E-Comprehension and E-Structural Analysis	27	+.05
E-Comprehension and E-Dictionary Skills	21	+.06
E-Visual and Auditory Discrimination and E-Structural Analysis	22	+.10
E-Structural Analysis and E-Dictionary Skills	21	-.15
F-Comprehension and F-Visual Discrimination	43	-.16
F-Comprehension and F-Auditory Discrimination	33	-.05
F-Comprehension and F-Structural Analysis	32	-.34
F-Comprehension and F-Phonetic Analysis	50	-.21
F-Comprehension and F-Dictionary Skills	49	-.02
F-Visual Discrimination and F-Auditory Discrimination	32	+.25
F-Visual Discrimination and F-Structural Analysis	29	+.19
F-Visual Discrimiantion and F-Phonetic Analysis	42	-.30*
F-Visual Discrimination and F-Dictionary Skills	45	-.13
F-Auditory Discrimination and F-Structural Analysis	24	+.14
F-Aduitory Discrimination and F-Phonetic Analysis	31	-.18
F-Auditory Discrimination and F-Dictionary Skills	32	-.01
F-Structural Analysis and F-Phonetic Analysis	29	+.08
F-Structural Analysis and F-Dictionary Skills	29	+.08
F-Phonetic Analysis and F-Dictionary Skills	50	-.09
G-Comprehension and G-Structural Analysis	33	+.01
G-Comprehension and G-Phonetic Analysis	31	-.00
G-Comprehension and G-Dictionary Skills	30	+.10
G-Structural Analysis and G-Phonetic Analysis	30	+.89**
G-Structural Analysis and G-Dictionary Skills	28	+.36
G-Phonetic Analysis and G-Dictionary Skills	28	+.38*
H-Comprehension and H-Structural Analysis	34	+.09
H-Comprehension and H-Phonetic Analysis	31	-.32
H-Comprehension and H-Dictionary Skills	22	-.32
H-Structural Analysis and H-Phonetic Analysis	26	+.16
H-Structural Analysis and H-Dictionary Skills	20	+.72**
H-Phonetic Analysis and H-Dictionary Skills	22	+.41

*Significant at the .05 level
**Significant at the .01 level

The question of consistency between the same topic at different levels is more difficult to examine because of the limited number of students who have progressed through one or more levels of work. Tables 11 and 12 present the correlation coefficients obtained between the time spent in the same topic at different levels in mathematics and reading respectively.

The correlation coefficient found in Table 11 between C-Addition and D-Addition is significantly different from zero at the .05 level but represents only a slight relationship between the two topics. The other three coefficients do not differ significantly from zero.

TABLE 11

CORRELATION BETWEEN THE TIME SPENT IN THE SAME TOPICS AT DIFFERENT LEVELS IN MATHEMATICS

UNITS	N	r
B-Numeration and C-Numeration	27	+.25
C-Place Value and D-Place Value	39	+.12
C-Addition and D-Addition	38	+.36*
C-Subtraction and D-Subtraction	31	+.02

*Significant at the .05 level

Table 12 presents five coefficients obtained when correlating rates for the same topic at different levels in reading but none of these coefficients differ significantly from zero. Therefore, from the correlation coefficients presented in Tables 11 and 12 it is concluded that there is no consistency between the time spent in the same topic at different levels in mathematics and reading.

These correlations are lower than might be anticipated. However, because of the variations from student to student in the intervening units which he would study between these pairs of units, it is possible that students entered the second level unit with prerequisite behaviors that were quite different from those suggested by their performance in the same unit at the first level.

TABLE 12

CORRELATION BETWEEN THE TIME SPENT IN THE SAME TOPICS AT DIFFERENT LEVELS IN READING

UNITS	N	r
E-Comprehension and F-Comprehension	23	-.10
F-Comprehension and G-Comprehension	34	-.03
G-Comprehension and H-Comprehension	24	-.22
F-Phonetic Analysis and G-Phonetic Analysis	28	-.18
F-Dictionary Skills and G-Dictionary Skills	30	-.06

The third manner in which the consistency of this measure of student learning rate was analyzed involved first identifying three or more units in either the mathematics or reading curriculum that nineteen or more students had completed. The consistency of the student's rate of learning over these units was then investigated by Hoyt's[1] analysis of variance procedures for determining reliability. Table 13 presents the F ratio (mean square for individual/mean square for residual) and the reliability (R) for units in mathematics. The F ratio for the combination of the C-Place Value, C-Addition, C-Subtraction and C-Fraction is significant which means that total measures based on these four units show significant differences among individual students. The reliability estimate for this total is .49. Also, the F ratio, 2.178, obtained for the units, D-Fraction, D-Time, and D-System of Measure is significant at the .01 level and the total measure here has a reliability of .54.

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[1] Robert F. Thorndike, "Reliability," E. F. Lindquist, (ed.), Educational Measurement. Meansha, Wisconsin: George Banto Publishing Company, 1955, pp. 590-591.

TABLE 13

CONSISTENCY OF DAY RATE MEASURES IN MATHEMATICS

UNITS	N	F	R
B-Numeration, C-Numeration, C-Place Value	25	1.303	+.23
C-Addition, C-Subtraction, C-Fraction	25	1.551	+.36
C-Place Value, C-Addition, C-Subtraction			
D-Place Value, D-Addition, D-Subtraction	22	.720	-.38
D-Fraction, D-Time, D-System of Measure	28	2.178**	+.54
D-Addition, D-Subtraction, D-Multiplication, D-Division	23	1.512	+.34
C-Numeration, C-Place Value, C-Addition, C-Subtraction	19	.522	-.09
C-Place Value, C-Addition, C-Subtraction, C-Fraction	25	1.959*	+.49

*Significant at the .05 level
**Significant at the .01 level

One explanation of the reliability for the units of D-Fraction, D-Time, and D-System of Measure is that these three units contained not only a limited number of learning experiences but also some of the poorest materials that were used in the mathematics curriculum. This possibly resulted in most students being assigned essentially the same material in all the units. Therefore, student rate became dependent on the working speed of the student and was not a function of variability in prescriptions.

Table 14 shows the F ratio's and R's that were obtained for units of the reading sequence. The only set of units that were found to have a significant F ratio was H-Structural Analysis, H-Phonetic Analysis, and H-Dictionary Skills. The computed F ratio of 3.211 exceeds the value 2.37 which was required for the F ratio to be significant at the .01 level. The reliability for these units was +.69. There is no readily evidenced explanation for the relatively high reliability obtained for these units.

TABLE 14

CONSISTENCY OF DAY RATE MEASURES IN READING

UNITS	N	F	R
F-Comprehension, F-Visual Discrimination, F-Auditory Discrimination	29	1.133	+.12
G-Comprehension, G-Structural Analysis, G-Phonetic Analysis	24	.751	-.33
F-Comprehension, G-Comprehension, H-Comprehension	19	.863	-.16
H-Comprehension, H-Structural Analysis, H-Phonetic Analysis, H-Dictionary Skills	20	.601	-.67
F-Comprehension, F-Visual Discrimination, F-Auditory Discrimination G-Structural Analysis, H-Phonetic Analysis, H-Dictionary Skills	20	3.211**	+.69

**Significant at the .01 level

The results from the analysis presented in Tables 13 and 14 indicate again that for the particular units analyzed there is no general consistency of this measure of student learning rate over units of mathematics or reading.

The final analysis concerning the consistency of this rate measure, number of days to complete a unit, was a study of the consistency that existed between the units in the mathematics and reading curriculum. The coefficients obtained from correlating units of mathematics with units in reading are shown in Table 15. Six of the coefficients are significantly different at the .05 level and two at the .01 level and, however, because of the large number of coefficients computed could have occurred by chance. The 172 coefficients ranged in value from a -.45, between D-Fraction and F-Auditory Discrimination, to a +.61, between C-Subtraction and F-Comprehension. Since these coefficients cover such a range from moderately negative to moderately positive and since only eight of the one hundred and seventy-two were significantly different from zero, it was assumed that the total evidence indicated that there is no relationship between the amount of time needed to master a unit of mathematics and a unit of reading.

It is very difficult to explain why eight of these correlation coefficients were significant except in terms of a chance factor that is allowed to operate when such a large number of correlations are performed. One reason that most of these correlations are near zero in value may be that at the beginning levels of the sequence (A, B, C, and D) the materials were difficult for many young students in that they were slowed down by the need for reading the instructions. This problem was partially corrected later through tutorial methods of teaching. This resolution of the problem meant that some students in the sample may have had to work a unit under conditions very different from other students in the sample.

TABLE 15

CORRELATION BETWEEN THE TIME SPENT IN MATHEMATICS AND READING UNITS

UNITS	N	r
C-Place Value and E-Comprehension	33	+.42*
D-Place Value and E-Visual and Adultory Discrimination	20	-.28
C-Place Value and E-Structural Analysis	24	-.15
C-Place Value and F-Comprehension	30	-.14
C-Place Value and F-Visual Discrimination	28	-.12
C-Place Value and F-Auditory Discrimination	21	-.19
C-Place Value and F-Structural Analysis	23	-.00
C-Place Value and F-Phonetic Analysis	22	+.20
C-Place Value and F-Dictionary Skills	27	-.41*
C-Addition and E-Comprehension	29	+.22
C-Addition and E-Structural Analysis	23	-.12
C-Addition and F-Comprehension	32	-.05
C-Addition and F-Visual Discrimination	26	+.05
C-Addition and F-Auditory Discrimination	22	+.31
C-Addition and F-Structural Analysis	23	+.20
C-Addition and F-Phonetic Analysis	24	-.01
C-Addition and F-Dictionary Skills	29	-.21
C-Subtraction and E-Comprehension	34	-.03
C-Subtraction and E-Visual and Auditory Discrimination	21	-.42
C-Subtraction and E-Structural Analysis	26	-.32
C-Subtraction and E-Dictionary Skills	20	+.38
C-Subtraction and F-Comprehension	32	+.61**
C-Subtraction and F-Visual Discrimination	28	-.09
C-Subtraction and F-Auditory Discrimination	22	-.01
C-Subtraction and F-Structural Analysis	24	-.24
C-Subtraction and F-Phonetic Analysis	24	-.18
C-Subtraction and F-Dictionary Skills	27	-.08
C-Combination of Processes and E-Comprehension	36	-.17
C-Combination of Processes and E-Visual and Auditory Discrimination	22	-.04
C-Combination of Processes and E-Structural Analysis	27	+.05
C-Combination of Processes and E-Dictionary Skills	21	-.11
C-Combination of Processes and F-Comprehension	31	-.20
C-Combination of Processes and F-Visual Discrimination	27	-.11
C-Combination of Processes and F-Auditory Discrimination	21	-.15
C-Combination of Processes and F-Structural Analysis	23	-.21
C-Combination of Processes and F-Phonetic Analysis	21	-.11
C-Combination of Processes and F-Dictionary Skills	27	-.35
C-Fraction and E-Comprehension	22	+.04
C-Fraction and F-Comprehension	28	+.03
C-Fraction and F-Visual Discrimination	25	+.01
C-Fraction and F-Auditory Discrimination	22	-.03
C-Fraction and F-Structural Analysis	21	-.07

TABLE 15 (continued)

CORRELATION BETWEEN THE TIME SPENT IN MATHEMATICS AND READING UNITS

UNITS	N	r
C-Fraction and F-Phonetic Analysis	22	+.33
C-Fraction and F-Dictionary Skills	28	-.39*
C-Time and F-Comprehension	21	+.28
C-Time and F-Visual Discrimination	20	+.23
C-Time and F-Phonetic Analysis	22	+.25
C-Time and F-Dictionary Skills	29	-.00
C-Time and G-Comprehension	20	+.05
C-System of Measure and E-Comprehension	25	-.15
C-System of Measure and E-Structural Analysis	21	+.09
C-System of Measure and F-Comprehension	28	+.01
C-System of Measure and F-Visual Discrimination	25	+.52**
C-System of Measure and F-Dictionary Skills	25	-.22
C-Special Topics and E-Comprehension	24	+.10
C-Special Topics and E-Structural Analysis	20	+.05
C-Special Topics and F-Comprehension	24	-.38
C-Special Topics and F-Visual Discrimination	23	-.17
C-Special Topics and F-Dictionary Skills	20	-.28
D-Numeration and E-Comprehension	26	-.36
D-Numeration and E-Structural Analysis	20	-.03
D-Numeration and F-Comprehension	30	+.24
D-Numeration and F-Visual Discrimination	26	+.44*
D-Numeration and F-Auditory Discrimination	23	+.09
D-Numeration and F-Structural Analysis	21	-.02
D-Numeration and F-Phonetic Analysis	23	+.02
D-Numeration and F-Dictionary Skills	26	+.18
D-Place Value and E-Comprehension	24	-.25
D-Place Value and F-Comprehension	34	-.14
D-Place Value and F-Visual Discrimination	30	+.32
D-Place Value and F-Auditory Discrimination	23	+.17
D-Place Value and F-Structural Analysis	24	-.03
D-Place Value and F-Phonetic Analysis	26	-.03
D-Place Value and F-Dictionary Skills	34	-.31
D-Addition and E-Comprehension	22	+.12
D-Addition and F-Comprehension	39	-.15
D-Addition and F-Visual Discrimiantion	36	-.06
D-Addition and F-Auditory Discrimination	27	+.12
D-Addition and F-Structural Analysis	26	+.24
D-Addition and F-Phonetic Analysis	35	-.05
D-Addition and F-Dictionary Skills	43	+.21
D-Addition and G-Comprehension	22	+.17
D-Subtraction and E-Comprehension	20	-.36
D-Subtraction and F-Comprehension	34	+.10
D-Subtraction and F-Visual Discrimination	34	-.29

TABLE 15 (continued)

CORRELATION BETWEEN THE TIME SPENT IN MATHEMATICS AND READING UNITS

UNITS	N	r
D-Subtraction and F-Auditory Discrimination	23	-.19
D-Subtraction and F-Structural Analysis	25	+.13
D-Subtraction and F-Phonetic Analysis	30	+.19
D-Subtraction and F-Dictionary Skills	40	+.11
D-Subtraction and G-Comprehension	24	+.17
D-Multiplication and F-Comprehension	28	+.04
D-Multiplication and F-Visual Discrimination	25	-.23
D-Multiplication and F-Phonetic Analysis	26	-.07
D-Division and F-Comprehension	25	+.17
D-Division and F-Visual Discrimination	25	-.08
D-Division and F-Phonetic Analysis	26	+.08
D-Division and F-Dictionary Skills	33	+.06
D-Division and G-Comprehension	26	-.05
D-Combination of Processes and F-Comprehension	24	-.23
D-Combination of Processes and F-Visual Discrimination	23	+.30
D-Combination of Processes and F-Phonetic Analysis	25	-.05
D-Combination of Processes and F-Dictionary Skills	30	-.15
D-Combination of Processes and G-Comprehension	24	-.23
D-Fraction and F-Comprehension	32	-.06
D-Fraction and F-Visual Discrimination	29	+.15
D-Fraction and F-Auditory Discrimination	20	-.45*
D-Fraction and F-Phonetic Analysis	34	+.17
D-Fraction and F-Dictionary Skills	40	-.29
D-Fraction and G-Comprehension	37	+.17
D-Fraction and G-Structural Analysis	32	-.06
D-Fraction and G-Phonetic Analysis	29	+.03
D-Fraction and G-Dictionary Skills	26	-.10
D-Fraction and H-Comprehension	31	+.20
D-Fraction and H-Structural Analysis	23	+.04
D-Fraction and H-Phonetic Analysis	20	+.00
D-Money and F-Comprehension	21	-.10
D-Money and F-Phonetic Analysis	21	-.16
D-Money and F-Dictionary Skills	25	-.11
D-Money and G-Comprehension	21	+.28
D-Time and F-Comprehension	23	+.10
D-Time and F-Phonetic Analysis	25	+.01
D-Time and F-Dictionary Skills	29	+.12
D-Time and G-Comprehension	28	-.10
D-Time and G-Structural Analysis	29	-.26
D-Time and G-Phonetic Analysis	28	-.16
D-Time and G-Dictionary Skills	26	+.19
D-Time and H-Comprehension	30	-.00
D-Time and H-Structural Analysis	22	+.34

TABLE 15 (continued)

CORRELATION BETWEEN THE TIME SPENT IN MATHEMATICS AND READING UNITS

UNITS	N	r
D-System of Measure and F-Comprehension	25	-.10
D-System of Measure and F-Visual Discrimination	25	+.19
D-System of Measure and F-Phonetic Analysis	29	-.08
D-System of Measure and F-Dictionary Skills	31	+.25
D-System of Measure and G-Comprehension	28	+.04
D-System of Measure and G-Structural Analysis	30	-.09
D-System of Measure and G-Phonetic Analysis	27	-.03
D-System of Measure and G-Dictionary Skills	25	-.13
D-System of Measure and H-Comprehension	30	-.09
D-System of Measure and H-Structural Analysis	22	+.26
D-System of Measure and H-Phonetic Analysis	21	+.05
D-Geometry and F-Comprehension	22	+.07
D-Geometry and F-Visual Discrimination	21	-.45*
D-Geometry and F-Phonetic Analysis	26	+.31
D-Geometry and F-Dictionary Skills	30	-.27
D-Geometry and G-Comprehension	28	-.13
D-Geometry and G-Structural Analysis	28	+.03
D-Geometry and G-Phonetic Analysis	26	-.07
D-Geometry and G-Dictionary Skills	24	+.04
D-Geometry and H-Comprehension	23	+.21
D-Special Topics and F-Dictionary Skills	25	+.06
E-Numeration and F-Phonetic Analysis	21	+.32
E-Numeration and F-Dictionary Skills	27	+.32
E-Numeration and G-Comprehension	23	+.19
E-Numeration and G-Phonetic Analysis	20	-.12
E-Numeration and H-Comprehension	20	-.29
E-Place Value and F-Comprehension	22	-.24
E-Place Value and F-Phonetic Analysis	25	+.04
E-Place Value and F-Dictionary Skills	29	+.18
E-Place Value and G-Comprehension	27	+.20
E-Place Value and G-Structural Analysis	27	-.08
E-Place Value and G-Phonetic Analysis	26	-.06
E-Place Value and G-Dictionary Skills	27	-.05
E-Place Value and H-Comprehension	33	+.05
E-Place Value and H-Structural Analysis	26	-.07
E-Place Value and H-Phonetic Analysis	24	-.20
E-Place Value and H-Dictionary Skills	20	-.25
E-Multiplication and F-Dictionary Skills	21	-.12
E-Multiplication and G-Structural Analysis	22	-.05
E-Multiplication and G-Phonetic Analysis	20	-.08
E-Multiplication and H-Comprehension	30	-.11
E-Multiplication and H-Structural Analysis	22	-.03
E-Geometry and H-Comprehension	21	+.21

*Significant at the .05 level
**Significant at the .01 level

As with the previous measure of learning rate that was investigated, this measure, involving time spent on given units, was also studied with respect to its relationship with student intelligence. Table 16 represents the Pearson product-moment correlation coefficients between student intelligence and the number of days required to complete a given unit of work in mathematics.

Of the thirty-six correlation coefficients computed, only seven were found to be significantly different from zero at the .05 level or less. Five of these significant correlations, found in connection with the units of B-System of Measure, C-Place Value, C-Subtraction, C-Fraction and D-Numeration, and D-Combination of Processes, were negative and indicate that there is an inverse relationship between student intelligence and the amount of time required to master these units of work. A negative correlation indicates that the higher the student's intelligence the less time he would require to master the unit while a positive correlation indicates that the higher the intelligence the longer the time required to master the unit. Because of the small number of significant correlation coefficients and the fact that even these significant coefficients are quite small, it must be concluded that, in general, there is no relationship between student intelligence and the number of days to complete a given unit of mathematics.

When the relationship between student intelligence and the number of days required to master units of reading was investigated, similar results were found as indicated by the correlation coefficients in Table 17. Of the eighteen units that were used in this analysis only three, F-Phonetic Analysis, F-Dictionary Skills, and G-Structural Analysis had correlation coefficients that were significantly different from zero at the .05 level and these were low in value.

TABLE 16

CORRELATION BETWEEN STUDENT INTELLIGENCE AND THE TIME SPENT IN UNITS OF MATHEMATICS

VARIABLES	N	r
B-Numeration and student intelligence	33	+.11
B-Addition and student intelligence	28	+.24
B-System of Measure and student intelligence	23	-.47**
C-Numeration and student intelligence	44	+.04
C-Place Value and student intelligence	76	-.31*
C-Addition and student intelligence	57	+.07
C-Subtraction and student intelligence	64	-.33**
C-Combination of Processes and student intelligence	62	-.22
C-Fraction and student intelligence	46	-.36*
C-Money and student intelligence	24	+.08
C-Time and student intelligence	34	-.24
C-System of Measure and student intelligence	41	+.10
C-Geometry and student intelligence	24	+.43*
C-Special Topics and student intelligence	38	+.13
D-Numeration and student intelligence	45	-.40**
D-Place Value and student intelligence	47	-.24
D-Addition and student intelligence	55	+.14
D-Subtraction and student intelligence	54	+.04
D-Multiplication and student intelligence	39	+.27
D-Division and student intelligence	36	+.05
D-Combination of Processes and student intelligence	38	-.37*
D-Fraction and student intelligence	54	-.26
D-Money and student intelligence	31	+.02
D-Time and student intelligence	44	-.07
D-System of Measure and student intelligence	45	+.12
D-Geometry and student intelligence	39	-.23
D-Special Topics and student intelligence	28	+.21
E-Numeration and student intelligence	35	-.06
E-Place Value and student intelligence	44	-.10
E-Addition and student intelligence	23	+.15
E-Subtraction and student intelligence	21	-.03
E-Multiplication and student intelligence	37	-.18
E-Division and student intelligence	23	+.08
E-Combination of Processes and student intelligence	24	-.22
E-Fraction and student intelligence	21	+.04
E-Addition and student intelligence	20	-.11

*Significant at the .05 level
**Significant at the .01 level

TABLE 17

CORRELATION BETWEEN STUDENT INTELLIGENCE AND THE TIME SPENT IN UNITS OF READING

VARIABLES	N	r
E-Comprehension and student intelligence	36	-.19
E-Visual and Auditory Discrimination and student intelligence	22	+.14
E-Structural Analysis and student intelligence	27	-.28
E-Dictionary Skills and student intelligence	21	-.08
F-Comprehension and student intelligence	63	-.12
F-Visual Discrimination and student intelligence	54	+.06
F-Auditory Discrimination and student intelligence	37	-.02
F-Structural Analysis and student intelligence	37	+.13
F-Phonetic Analysis and student intelligence	57	-.28*
F-Dictionary Skills and student intelligence	65	+.27*
G-Comprehension and student intelligence	46	+.09
G-Structural Analysis and student intelligence	39	+.31*
G-Phonetic Analysis and student intelligence	36	+.31
G-Dictionary Skills and student intelligence	34	+.02
H-Comprehension and student intelligence	48	-.05
H-Structural Analysis and student intelligence	36	+.15
H-Phonetic Analysis and student intelligence	32	+.13
H-Dictionary Skills and student intelligence	23	+.33

*Significant at the .05 level

From the results indicated in Tables 16 and 17 it can be concluded that, in general, there was no relationship between student intelligence and the amount of time requires to master a unit in either the mathematics or the reading curriculum.

One difficulty in interpreting this relationship between student intelligence and the number of days spent in units of mathematics and reading is the different grade levels of students taking a particular unit. For an example, this could result in a low-ability fifth grade student taking a unit, C-Multiplication, as a review type learning experience, and a high-ability second grade student who is encountering this unit for the first time. In this situation they both may master the unit in the same amount of working time and there would be essentially no relationship between intelligence and number of days to complete unit.

The next student characteristic that was investigated was student level of reading achievement and its relationship to the amount of time required to master a given unit of work.

The correlation coefficients resulting from correlating student reading level with the amount of time spent in selected units of mathematics are shown in Table 18. The thirty correlation coefficients range from -.50 through +.17. Of these correlations, those for units B-Addition and C-Fraction are significantly different from zero at the .05 level while those for C-Place Value and C-Addition are significantly different from zero at the .01 level. In view of the large amount of direction reading required by the student in the mathematics curriculum, these results are much lower than would be anticipated. Possibly one reason for this is that students in the primary grades often had to wait for teacher assistance before they could procede with fulfilling their prescriptions. Since only four of the thirty coefficients are significant, the general conclusion has to be that there is no relationship between student reading level and the rate at which a student masters a given unit of mathematics.

Similarly, the results obtained when analyzing the relationship between student reading level and the time needed to master selected units of reading are presented in Table 19. The seventeen correlation coefficients that were computed range from r = -.32 to r = +.46. Only three of these correlations, F-Comprehension, F-Visual Discrimination, and H-Structural Analysis are significantly different from zero at the .05 level or less.

TABLE 18

CORRELATION BETWEEN TIME SPENT IN MATHEMATIC UNITS AND LEVEL OF READING ACHIEVEMENT

VARIABLES	N	r
B-Numeration and level of reading achievement	33	-.10
B-Addition and level of reading achievement	26	-.42*
B-System of Measure and level of reading achievement	23	-.01
C-Numeration and level of reading achievement	42	-.25
C-Place Value and level of reading achievement	72	-.50**
C-Addition and level of reading achievement	53	-.44**
C-Subtraction and level of reading achievement	60	+.06
C-Combination of Processes and level of reading achievement	58	-.17
C-Fraction and level of reading achievement	46	-.31*
C-Money and level of reading achievement	24	+.14
C-Time and level of reading achievement	32	-.01
C-System of Measure and level of reading achievement	40	-.11
C-Geometry and level of reading achievement	22	-.25
C-Special Topics and level of reading achievement	36	-.29
D-Numeration and level of reading achievement	42	+.14
D-Place Value and level of reading achievement	45	-.13
D-Addition and level of reading achievement	53	-.04
D-Subtraction and level of reading achievement	52	+.01
D-Multiplication and level of reading achievement	38	-.22
D-Division and level of reading achievement	36	-.21
D-Combination of Processes and level of reading achievement	35	+.03
D-Fraction and level of reading achievement	47	+.00
D-Money and level of reading achievement	26	+.16
D-Time and level of reading achievement	33	-.01
D-System of Measure and level of reading achievement	35	+.09
D-Geometry and level of reading achievement	31	-.00
D-Special Topics and level of reading achievement	28	+.17
E-Numeration and level of reading achievement	30	-.02
E-Place Value and level of reading achievement	33	-.02
E-Multiplication and level of reading achievement	25	-.37

*Significant at the .05 level
**Significant at the .01 level

When examining the coefficients that were obtained for the various levels (E, F, G, H) of Structural Analysis an increasing order of magnitude was observed. There is no readily apparent explanation for this increase, however, it would seem to be of importance when the reading curriculum is analyzed in terms of sequencing topics and materials.

As is demonstrated in Tables 18 and 19, in general, there is no relationship between student reading level and the amount of time required to master selected units of mathematics or reading.

TABLE 19

CORRELATION BETWEEN TIME SPENT IN READING UNITS AND LEVEL OF READING ACHIEVEMENT

VARIABLES	N	r
E-Comprehension and level of reading achievement	36	-.24
E-Visual and Auditory Discrimination and level of reading achievement	22	-.01
E-Structural Analysis and level of reading achievement	27	-.03
E-Dictionary Skills and level of reading achievement	21	-.01
F-Comprehension and level of reading achievement	53	-.32*
F-Visual Discrimination and level of reading achievement	48	+.41**
F-Auditory Discrimination and level of reading achievement	34	+.21
F-Structural Analysis and level of reading achievement	31	+.05
F-Phonetic Analysis and level of reading achievement	48	-.18
F-Dictionary Skills and level of reading achievement	60	-.01
G-Comprehension and level or reading achievement	37	-.17
G-Structural Analysis and level of reading achievement	31	+.20
G-Phonetic Analysis and level of reading achievement	29	+.23
G-Dictionary Skills and level of reading achievement	28	-.03
H-Comprehension and level of reading achievement	32	-.15
H-Structural Analysis and level of reading achievement	24	+.46*
H-Phonetic Analysis and level of reading achievement	20	+.05

*Significant at the .05 level
**Significant at the .01 level

C. Average Daily Achievement As a Measure of Student Learning Rate

The third rate measure that was investigated in this study was student average daily achievement. This particular rate measure was determined by finding the difference between the pre-test score and the criterion (100) and dividing this by the number of days required to master the unit. The only units used in this analysis were those in which a lack of mastery was demonstrated by the student on the pre-test. Because of the selection process, smaller samples were used in this part of the investigation than with the two previous measures of student learning rate. For this rate measure, samples involving an N of fifteen or greater were analyzed.

As with the previous rate measure, number of days required to complete a unit, the consistency of the rate measure, average daily achievement, was examined in the following manner: (1) the consistency between this measure of learning rate in different topics within the same level of work, (2) the consistency of the measure of learning rate in the same topic at different levels, (3) the consistency of this measure of student learning rate over three or more units of work and (4) the consistency of rate of student learning between units of mathematics and reading.

The consistency of the rate measure, average daily achievement was examined in the first context by correlating topics within a given level in both the mathematics and reading curriculum. Tables 20 and 21 represent the coefficients obtained in mathematics and reading respectively. Table 20 shows that only the coefficient, $r = +.42$, obtained when C-Addition and C-Fractions were correlated, was significantly different from zero at .01 level. The correlation, between D-Combination of Processes and D-Fraction is significant of the .05 level but it is a relatively low value when it is considered as a measure of consistency. The fact that this correlation was higher than the rest of the correlations can possibly be attributed to the materials that were available. The materials, particularly for D-Fraction, were poor in quality and did not provide the same degree of individualization that was found with other units. Caution must also be exercised in regard to any interpretation of this coefficient because of the limited sample size. In general, it can be concluded, that there is no consistency in the average daily rate of achievement between topics within a given level of mathematics

TABLE 20

CORRELATION BETWEEN STUDENT AVERAGE DAILY ACHIEVEMENT
IN DIFFERENT UNITS AT THE SAME LEVEL IN MATHEMATICS

UNITS	N	r
B-Numeration and B-Addition	27	-.23
C-Numeration and C-Place Value	24	-.17
C-Numeration and C-Addition	23	+.02
D-Numeration and C-Subtraction	16	+.36
C-Place Value and C-Addition	28	+.04
C-Place Value and C-Subtraction	19	+.03
C-Place Value and C-Fraction	17	-.30
C-Addition and C-Subtraction	45	-.31
C-Addition and C-Fraction	40	+.42**
C-Addition and C-Geometry	16	+.20
C-Subtraction and C-Fraction	33	+.28
D-Numeration and D-Place Value	16	+.13
D-Subtraction and D-Multiplication	16	-.20
D-Subtraction and D-Fraction	18	+.36
D-Multiplication and D-Fraction	15	+.22
D-Division and D-Fraction	18	+.09
D-Combination of Processes and D-Fraction	15	+.60*
D-Fraction and D-Money	17	+.06
D-Fraction and D-Geometry	24	+.15

*Significant at the .05 level
**Significant at the .01 level

Table 21 presents the coefficients obtained when different units at the same level in reading are correlated. These correlations range from r + -.32 to r = +.23 with none of the coefficients differing significantly from zero.

TABLE 21

CORRELATION BETWEEN STUDENT AVERAGE DAILY ACHIEVEMENT IN DIFFERENT UNITS AT THE SAME LEVEL IN READING

UNITS	N	r
F-Comprehension and F-Visual Discrimination	21	-.23
F-Comprehension and F-Phonetic Analysis	37	-.15
F-Comprehension and F-Dictionary Skills	21	+.03
F-Visual Discrimination and F-Phonetic Analysis	21	-.32
F-Visual Discrimination and F-Dictionary Skills	15	-.32
F-Phonetic Analysis and F-Dictionary Skills	21	-.08
H-Comprehension and H-Structural Analysis	16	+.23
H-Comprehension and H-Dictionary Skills	16	-.26

From Table 20 and 21 it is evident that there is no consistency on this rate measure between different units at the same level in reading or mathemtaics.

The second situation to be analyzed concerned the consistency of the rate measure, average daily achievement, was between the same unit at different levels in mathematics and reading. This particular analysis was impaired because of the small number of students who progressed through more than a single level in either of the curriculum areas. Table 22 presents the correlation coefficients between B- and C-Addition and C- and D-Subtraction. Both of these correlations, r = -.02 and r = -.12, do not differ significantly from zero. Based upon this limited sample it would appear that there is no consistency between the same units at different levels in mathematics.

Table 23 presents coefficients obtained when rates in F-Comprehension and G-Comprehension were correlated. Although this coefficient is significantly different from zero, no conclusion can be drawn from this single correlation because of the small sample size and lack of supporting data.

TABLE 22

CORRELATION BETWEEN STUDENT AVERAGE DAILY ACHIEVEMENT IN THE SAME UNIT AT DIFFERENT LEVELS IN MATHEMATICS

UNITS	N	r
B-Addition and C-Addition	24	-.02
C-Subtraction and D-Subtraction	15	-.12

TABLE 23

CORRELATION BETWEEN STUDENT AVERAGE DAILY ACHIEVEMENT IN THE SAME UNIT AT DIFFERENT LEVELS IN READING

UNITS	N	r
F-Comprehension and G-Comprehension	14	+.53*

*Significant at the .05 level

The third situation that was analyzed concerning the rate measure, average daily achievement, was consistency of student performance over a series of three units of work in the curriculum of mathematics and reading. Hoyt's[1] procedures for determining reliability was utilized in analyzing the consistency of this measure of student performance.

Table 25 shows the units, number of cases, F ratio between the sum of squares for the individual and the sum of squares for the interaction, and the reliability for units in mathematics. None of the six F ratios are significant at the .05 level or less and, therefore, none of the reliabilities are meaningful.

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[1] Thorndike, op. cit.

TABLE 24

CONSISTENCY OF STUDENT LEARNING RATE MEASURE, AVERAGE DAILY ACHIEVEMENT, OVER UNITS IN MATHEMATICS

UNITS	N	F	R
C-Addition, C-Subtraction, C-Fraction	26	1.05	+.05
C-Addition, C-Subtraction, D-Numeration	16	1.21	+.17
C-Addition, C-Fraction, D-Multiplication	13	1.369	+.27
C-Subtraction, C-Fraction, D-Numeration	10	1.450	+.31
C-Place Value, C-Addition, C-Subtraction	11	1.771	+.44
C-Fraction, D-Numeration, D-Place Value	10	.826	-.21

TABLE 25

CONSISTENCY OF STUDENT LEARNING RATE MEASURE, AVERAGE DAILY ACHIEVEMENT, OVER UNITS IN READING

UNITS	N	F	R
F-Comprehension, F-Structural Analysis, F-Phonetic Analysis	10	.763	-.69
F-Comprehension, F-Phonetic Analysis, G-Structural Analysis	18	.981	-.02
F-Phonetic Analysis, G-Structural Analysis, H-Comprehension	13	1.113	+.10
F-Visual Discrimination, F-Phonetic Analysis, H-Comprehension	10	.861	-.17

Table 25 represents the same information as the previous table except in this case the units involved are from the reading curriculum. As indicated by this table, the results in reading are similar to those found in mathematics. None of the F ratio's are significant and the R coefficients range from -.69 to +.10.

As evident in Tables 24 and 25, there is no consistency in student learning rate as measured by average daily achievement in mathematics or reading.

The fourth and final manner in which the consistency of this rate measure was investigated was through a correlational study between the units in the mathematics and reading curriculum. Table 26 presents the resulting correlation coefficients between the units of mathematics and reading. Two of the coefficients, -.46 between C-Fraction and F-Comprehension, and -.59 between D-Place Value and F-Comprehension, are significant at the .05 level. Only one of the coefficients, r = +.67 between D-Subtraction and F-Phonetic Analysis is significant at the .01 level. These few significant correlations could be a result of a chance factor operating when this many correlations are computed. In addition to this, the sample sizes are very small.

Because of the wide range of values for coefficients and the fact that only three of the twenty-five coefficients are significantly different from zero, it can be concluded that there is no consistency between student average daily achievement in mathematics and units in reading.

Again as with the previous measure of learning rate, the relationships between student average daily achievement and the student characteristics of intelligence and level of reading achievement were studied. In Table 27 is presented the correlation coefficients that were obtained when student average daily achievement in mathematics was correlated with student intelligence. Only the coefficient between C-Fractions and student intelligence, r = +.35, was significantly different from zero and then only at the .05 level. The other twenty-four coefficients do not differ significantly from zero and range in value from r = -.34 to r = +.35. As has been mentioned in other sections where the unit of C-Fraction was used as part of the analysis, this unit suffered from the number of learning experiences that could be assigned and the quality of materials available. From this table it is evident that there is no relationship between student intelligence and average daily achievement in mathematics.

TABLE 26

CORRELATION BETWEEN RATE MEASURES OF AVERAGE DAILY ACHIEVEMENT IN MATHEMATICS AND READING

UNITS	N	r
C-Addition and E-Auditory and Visual Discrimination	15	+.36
C-Addition and F-Comprehension	23	-.20
C-Subtraction and F-Comprehension	22	+.42
C-Fraction and F-Comprehension	20	-.46*
D-Place Value and F-Comprehension	15	-.59*
D-Subtraction and F-Comprehension	18	-.08
D-Subtraction and F-Phonetic Analysis	16	+.67**
D-Subtraction and F-Dictionary Skills	17	+.40
D-Multiplication and F-Comprehension	16	+.49
D-Division and F-Comprehension	19	+.04
D-Combination of Processes and F-Comprehension	15	-.10
D-Combination of Processes and F-Phonetic Analysis	15	+.48
D-Fraction and F-Comprehension	28	-.12
D-Fraction and F-Visual Discrimination	20	-.02
D-Fraction and F-Phonetic Analysis	29	+.26
D-Fraction and F-Dictionary Skills	20	+.03
D-Fraction and G-Comprehension	17	-.15
D-Fraction and G-Structural Analysis	21	+.40
D-Fraction and H-Comprehension	23	+.06
D-Geometry and F-Comprehension	16	-.37
D-Geometry and F-Phonetic Analysis	19	-.16
E-Place Value and H-Comprehension	15	-.12
E-Multiplication and H-Comprehension	17	+.43
E-Geometry and H-Comprehension	21	+.16
F-Addition and H-Comprehension	15	+.41

*Significant at the .05 level
**Significant at the .01 level

The same inconsistent pattern is found when student intelligence is correlated with average daily achievement in reading. Table 27 shows the correlation coefficients that were obtained when these variables were correlated. The coefficients of $r = +.42$ between G-Structural Analysis and student intelligence was the only correlation that was significantly different from zero. From Table 28 it is evident that there is no correlation between student intelligence and student average daily achievement in reading.

TABLE 27

CORRELATION BETWEEN STUDENT AVERAGE DAILY ACHIEVEMENT IN MATHEMATICS AND INTELLIGENCE

UNITS	N	r
B-Numeration and student intelligence	29	-.14
B-Addition and student intelligence	27	-.09
C-Numeration and student intelligence	30	-.18
C-Place Value and student intelligence	41	+.05
C-Addition and student intelligence	56	+.12
C-Subtraction and student intelligence	55	-.03
C-Fraction and student intelligence	50	+.35*
C-Geometry and student intelligence	23	+.02
D-Numeration and student intelligence	28	+.28
D-Place Value and student intelligence	27	-.22
D-Addition and student intelligence	23	-.22
D-Subtraction and student intelligence	36	+.09
D-Multiplication and student intelligence	28	+.13
D-Division and student intelligence	23	-.13
D-Combination of Processes and student intelligence	23	-.05
D-Fraction and student intelligence	50	+.23
D-Money and student intelligence	21	+.26
D-Geometry and student intelligence	29	+.17
E-Numeration and student intelligence	18	+.08
E-Place Value and student intelligence	27	-.06
E-Multiplication and student intelligence	25	+.15
E-Division and student intelligence	16	-.10
E-Geometry and student intelligence	24	+.11
F-Numeration and student intelligence	15	-.34
F-Addition and student intelligence	17	-.30

*Significant at the .05 level

The findings represented in Tables 27 and 28 are consistent with those found with the previous rate measure--number of days required to complete unit. There is no relationship between student intelligence and the daily amount of content mastered in mathematics or reading.

TABLE 28

CORRELATION BETWEEN STUDENT INTELLIGENCE AND AVERAGE DAILY ACHIEVEMENT IN READING

UNITS	N	r
E-Visual and Auditory Discrimination and student intelligence	16	-.29
F-Comprehension and student intelligence	55	+.00
F-Visual Discrimination and student intelligence	34	+.23
F-Structural Analysis and student intelligence	17	+.05
F-Phonetic Analysis and student intelligence	47	+.09
F-Dictionary Skills and student intelligence	33	-.06
G-Comprehension and student intelligence	21	-.16
G-Structural Analysis and student intelligence	30	+.42*
H-Comprehension and student intelligence	41	+.04
H-Structural Analysis and student intelligence	20	-.07
H-Phonetic Analysis and student intelligence	17	-.18
I-Comprehension and student intelligence	19	+.06

*Significant at the .05 level

The other student characteristic studied was that of student level of reading achievement. The correlation coefficients obtained between student level of reading achievement and average daily achievement in mathematics are shown in Table 29. Three of the coefficients, those between student reading level and rate in C-Addition, C-Fraction and E-Division are significantly different from zero at the .01 level. Although two of these correlations show a substantial relationship, +.53 and +.66, the other twenty-one coefficients do not. These few significant relationships are difficult to explain except possibly in terms of materials that were employed and the structuring of the skills that comprised the units.

TABLE 29

CORRELATION BETWEEN STUDENT AVERAGE DAILY ACHIEVEMENT IN MATHEMATICS UNITS AND READING ACHIEVEMENT LEVEL

VARIABLES	N	r
B-Numeration and level of reading achievement	28	-.07
B-Addition and level of reading achievement	25	-.11
C-Numeration and level of reading achievement	29	+.13
C-Place Value and level of reading achievement	37	+.26
C-Addition and level of reading achievement	53	+.39**
C-Subtraction and level of reading achievement	52	-.05
C-Fraction and level of reading achievement	48	+.53**
C-Geometry and level of reading achievement	22	+.29
D-Numeration and level of reading achievement	25	-.14
D-Place Value and level of reading achievement	25	-.24
D-Addition and level of reading achievement	23	-.04
D-Subtraction and level of reading achievement	34	+.20
D-Multiplication and level of reading achievement	27	+.32
D-Division and level of reading achievement	22	+.41
D-Combination of Processes and level of reading achievement	20	+.20
D-Fraction and level of reading achievement	43	+.16
D-Money and level of reading achievement	20	-.29
D-Geometry and level of reading achievement	24	-.04
E-Numeration and level of reading achievement	16	-.04
E-Place Value and level of reading achievement	20	-.03
E-Multiplication and level of reading achievement	18	+.14
E-Division and level of reading achievement	14	+.66**

**Significant at .01 level

A comparable finding is presented in Table 30 which shows correlation coefficients that are a result of correlating student average daily achievement in reading units with level of reading achievement. In this table two of the eight coefficients are significant at the .05 level.

TABLE 30

CORRELATION BETWEEN STUDENT AVERAGE DAILY ACHIEVEMENT IN READING UNITS AND READING ACHIEVEMENT LEVEL

VARIABLES	N	r
E-Visual and Auditory Discrimination and level of reading achievement	16	-.39
F-Comprehension and level of reading achievement	43	+.13
F-Visual Discrimination and level of reading achievement	30	-.31
F-Phonetic Analysis and level of reading achievement	37	+.33*
F-Dictionary Skills and level of reading achievement	30	-.05
G-Comprehension and level of reading achievement	16	+.52*
G-Structural Analysis and level of reading achievement	24	+.15
H-Comprehension and level of reading achievement	27	-.18

*Significant at the .05 level

Only the coefficient obtained in correlating student average daily achievement in G-Comprehension with level of reading achievement, r = +.52, indicates a significant relationship. Any attempt to attach much meaning to this coefficient is questionable because of the small sample size involved. In general the results indicate that there is no relationship between student average daily rate of achievement in reading and level of reading achievement.

Tables 27 through 30 demonstrate that the student characteristic of intelligence and level of reading are not related to student average daily achievement in reading or mathematics.

D. Relationship Between the Rate Measure of Average Daily Achievement and Time Needed to Complete Unit

The final analysis that was performed in this study was to determine if a relationship existed between the two measures of student learning rate, average daily achievement and time needed to complete a given unit of work.

It should be noted that these two measures were not independent but that average daily achievement was a function of the other measure, time needed to complete unit, in that this latter measure was found in the denominator of the index average daily achievement. This relationship was studied to determine the extent one measure is a valid substitute for the other. In this section as in the previous section, all units that were completed by fifteen or more students were used in the analysis.

The first analysis consisted of correlating the two rate measures obtained in units of mathematics. Table 31 presents the resulting correlational coefficients. Twenty-two of the twenty-four coefficients are significantly different from zero at the .01 level, and range in value from r = -.12 to r = -.82. The comparitive low correlation coefficient between number of days to complete unit and average daily achievement for the unit of B-Addition is difficult to explain. One reason might be that the students spent part of their time in receiving large-group instruction because of the difficulty the younger students encountered in reading directions. The negative correlations are to be expected since the denominator of the average daily achievement rate measure is the same as the second rate measure, number of days to complete unit. These coefficients indicate that there is a strong relationship between the two measures for units in mathematics.

The two rate measures were correlated for units of reading with Table 32 presenting the resulting coefficients. These coefficients suggest a moderate relationship between the two measures but one not quite as large as that found in the area of mathematics. For four of the units, F-Comprehension, F-Phonetic Analysis, G-Comprehension, and H-Comprehension, coefficients were obtained that were significantly different from zero at the .01 level while the remaining five coefficients were significant at the .05 level.

TABLE 31

CORRELATION BETWEEN RATE MEASURES OF STUDENT AVERAGE DAILY ACHIEVEMENT AND TIME SPENT TO COMPLETE UNIT IN MATHEMATICS

UNITS	N	r
B-Numeration	27	-.68**
B-Addition	27	-.12
C-Numeration	29	-.48**
C-Place Value	37	-.67**
C-Addition	53	-.58**
C-Subtraction	51	-.55**
C-Fraction	36	-.71**
C-Geometry	19	-.63**
D-Numeration	25	-.76**
D-Place Value	22	-.82**
D-Addition	20	-.59**
D-Subtraction	36	-.70**
D-Multiplication	26	-.72**
D-Division	21	-.65**
D-Combination of Processes	23	-.47*
D-Fraction	48	-.57**
D-Money	15	-.75**
D-Geometry	27	-.58**
E-Numeration	17	-.78**
E-Place Value	23	-.69**
E-Multiplication	23	-.64**
E-Division	15	-.71**
E-Geometry	22	-.67**
F-Addition	15	-.81**

*Significant at the .05 level
**Significant at the .01 level

It is evident from Tables 31 and 32 that there is a moderately strong relationship between the two measures of rate of student learning in the mathematics and reading curriculum but that the two measures are not equivalent.

TABLE 32

CORRELATION BETWEEN RATE MEASURE OF STUDENT AVERAGE DAILY ACHIEVEMENT AND TIME SPENT TO COMPLETE UNITS IN READING

UNITS	N	r
F-Comprehension	49	-.58**
F-Visual Discrimination	32	-.38*
F-Phonetic Analysis	44	-.57**
F-Dictionary Skills	33	-.43*
G-Comprehension	20	-.69**
G-Structural Analysis	28	-.38*
H-Comprehension	38	-.55**
H-Structural Analysis	16	-.59*
I-Comprehension	18	-.55*

*Significant at the .05 level
**Significant at the .01 level

V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This investigation studied three measures of student learning rate in terms of the consistency of each measure and the relationship between each measure and the student characteristics of intelligence and level of reading achievement. This summary will be organized on the same basis as Chapter 4, "Presentation of Data," and each rate measure will be independently discussed in terms of its consistency and its relationship to selected student characteristics. The final part of the summary will be concerned with the relationship between two of the measures of rate of student learning.

A. Summary

Number of Units Completed During One Year of Study

The first measure of student learning rate studied was the number of mathematics and reading units a student mastered during one year of work.

Of initial interest was the consistency of this measure in terms of the correlation between the number of mathematics and the number of reading units a student completed during one year of study. A correlation coefficient of +.31 was obtained that was significant at the .01 level and therefore allowing the rejection of null-hypothesis number 1. However, this does not indicate that there is a large proportion of shared variance between the two variables.

The relationship between this measure, number of units completed, in the areas of mathematics and reading and student intelligence were examined. The data indicate a slight but significant relationship .

between the number of mathematic units completed and student intelligence. This finding, however, was not duplicated when the number of reading units was correlated with student intelligence.

As an extension of the study of the relationship between student intelligence and the number of units mastered, the relationship between student intelligence and level of initial and final placement in the IPI sequence was investigated. Since rate has been measured in terms of number of units, level of initial and final placement were measured in the same manner. The correlation coefficient obtained indicates a moderate relationship between intelligence and the amount of content that a student has mastered in mathematics and reading prior to entering the IPI program. A moderate to strong relationship was also evidenced between student intelligence and the level of final attainment in the mathematics and reading curriculums.

These findings indicate that of the six null-hypotheses (2 through 7) that were tested, concerning the relationship of student intelligence to the rate measure of number of units completed in one year, only number 3 cannot be rejected. There does exist a moderate relationship between student intelligence and rate of learning when this is measured in terms of units of work. It is of interest to note that there is a moderate relationship between student intelligence and student initial and final placement in the mathematic and reading sequences and only a slight relationship between intelligence and total number of units completed. This will be examined further in the "Conclusions" section of this report.

The second student characteristic studied in conjunction with this measure of learning rate was level of student reading achievement. When this student variable was correlated with the number of mathematic units completed during one year a slight but significant relationship was evident. This relationship was not found when the reading curriculum was analyzed. Therefore, only null-hypothesis number 8 can be rejected; number 9 cannot be. One possible reason for these conflicting findings could be a function of the more restricted range of units mastered in the reading curriculum.

This measure of learning rate, number of units mastered, does seem to be related to the student characteristics of intelligence and level of reading achievement in the case of rate in mathematics but not reading.

In considering number of units completed in a school year as a measure of rate of learning certain points should be noted. First, of course, that it is a practical and meaningful measure in that it indicates how quickly a pupil can progress through a sequence of learning experiences when all the factors in the classroom that can effect student progress are allowed to operate. A second point is that, in using the number of units completed as a measure of learning rate, it is essentially impossible to make the units equivalent in difficulty or in the average time needed for mastery. Therefore, because of these complicating factors, additional measures were studied.

Number of Days to Master a Given Unit

To avoid the problem of varying unit difficulty a measure of student rate of learning in terms of number of days to complete a given unit was investigated.

The consistency of this rate measure was investigated between different topics at the same level, the same topic at different levels, over three or more topics at varying levels, and between the mathematics and reading curriculums.

The first situation, that of the consistency of the measure, number of days per unit between topics at the same level, resulted in few significant correlation coefficients in either mathematics or reading. In general there was no consistency between the rate in one topic and another topic at the same level. Therefore, the first part of the null-hypotheses numbers 10 and 11 cannot be rejected.

In studying the consistency between the same topics at different levels, a smaller number of samples were used because of the limited number of students completing enough units to cover more than one level of work. The correlation coefficients resulting from this analysis indicated a lack of consistency between the same topics at successive levels of complexity in both the mathematics and reading curriculum and the first part of the null-hypotheses numbers 12 and 13 cannot be rejected. However, caution should be exercised in drawing any definite conclusions because of the limited number of units involved.

In investigating the consistency of this measure of rate of learning over three or more units of work, Hoyt's[1] analysis of variance procedures for determining reliability was employed. In the mathematics curriculum there was only one F ratio that was significant at the .01 level, which was for the units of D-Fractions, D-Time and D-System of Measure. In general there is no significant difference between students when total rate measures are obtained over several units of work in either the mathematics or the reading curriculum and the first part of null-hypotheses 14 and 15 cannot be rejected.

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[1] Robert F. Thorndike, "Reliability," E. F. Lindquist, (ed.), Educational Measurement. Meansha, Wisconsin: George Banto Publishing Company, 1955, pp. 590-591.

The final study of consistency involved a correlational study between units of the mathematic sequence and the reading sequence. When rate measures in units of mathematics were correlated with those in reading there were, in general, no significant correlation coefficients and would result in not rejecting the sixteenth null-hypothesis. This appears to be in conflict with the finding that there was a significant relationship between the total number of mathematics and reading units completed in a period of one year.

This can be explained in terms of the type of rate measures that were employed. When the rate measure of days to complete unit was used, a single unit of the mathematics sequence was compared to a single unit of reading. In this manner the relationship between two specific tasks, one in mathematics and one in reading, was studied. When student rate was investigated in terms of the number of units completed in mathematics and reading, no consideration was given to the wide variety of tasks represented by this measure. In addition to this, the units were nonequivalent in difficulty or length. While the two measures are both measures of rate of learning, they are measuring two somewhat different things.

This measure was then studied in relationship to the student characteristics of intelligence and level of reading achievement.

The correlation coefficients obtained when student intelligence was correlated with the number of days required to master units in the mathematics curriculum are in general, not significantly different from zero. Of the seven out of the thirty-six coefficients that were significantly different from zero at the .05 level or less, six indicated a negative relationship and one a positive relationship. Similar results were obtained when this relationship between numbered days spent in units of reading and student intelligence was investigated. Because of these low, non-significant correlation coefficients, the first part of the null-hypotheses 17 and 18 cannot be rejected.

The second student variable that was investigated in conjunction with the rate measure number of days to complete unit was that of level of student reading achievement. The findings indicate that there is no general relationship between the time required to complete a given unit of mathematics or reading and student level of reading achievement. This result is interesting because, for the most part, the student learning experiences that were prescribed consisted of materials that required a great deal of reading. Because of these findings, the first part of the null-hypotheses 19 and 20 cannot be rejected.

Average Daily Achievement

The third measure of rate of learning to be studied was that of average daily achievement. This measure takes into account the entering behavior of the student by dividing the amount a student achieved in a unit by the time required to complete the unit. This rate measure was analyzed in the same manner as the previous measure, number of days to complete a unit.

The consistency of this measure of learning rate was studied in terms of the consistency between different topics at the same level, consistency between the same topics at different levels, consistency over three units, and consistency between the curriculum areas of mathematics and reading.

In investigating the first of these four relationships, consistency between the different topics at the same level in mathematics and reading, correlation coefficients were obtained of which only a few were significantly different from zero. This would result in not rejecting the second part of null-hypotheses 10 and 11.

The second study of consistency is more difficult to interpret because of the limited number of units that could be used in this analysis and the small size of the sample. Only two sets of correlations were computed for the mathematics curriculum and both of these were nonsignificant negative correlations. In reading, the only correlation coefficient that could be computed, produced an r of +.52. While this correlation was significantly different from zero at the .05 level, the sample size was very small, being only fourteen. On the basis of this rather tenuous evidence, the second part of the null-hypothesis 12 would not be rejected while the second part of the thirteenth hypothesis would be rejected. There is very little supporting evidence in either case and caution must be exercised if those results are to be utilized.

In applying Hoyt's[1] analysis of variance procedures for determining the reliability of student performance over a series of three units of work in mathematics or reading no significant F ratios were found. This lack of significance does not permit the rejection of the second part of null-hypotheses 14 or 15.

The fourth and final manner in which the consistency of this rate measure was examined, was a correlational study between units in mathematics and reading. Two of the correlation coefficients that were obtained were significantly different from zero at the .05 level and one at the .01 level. The remaining twenty-three coefficients did not differ significantly from zero. In general, therefore, the second part of null-hypothesis 16 cannot be rejected.

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[1] Thornkike, op. cit.

The student variables to be studied in conjunction with this measure were those of intelligence and level of reading achievement. No general significant relationship was found in either the mathematics or reading curriculum between this rate measure and student intelligence. These results are consistent with the finding for the previous rate measure, number of days required to complete unit. The second variable, student level of reading achievement, also was in general, found not to be associated with student average daily achievement in mathematics or reading and, again, this is in agreement with the findings of the previous measure of number of days to complete unit.

The lack of relationship between this rate measure for mathematics and reading and the student characteristic of intelligence and level of reading achievement does not permit the rejection of the second part of null-hypotheses 17 through 20.

Relationship Between Average Daily Achievement and Number of Days to Complete a Unit

Of interest to this study is the relationship that exists between the measures of student learning rate of number of days to complete a unit and average daily achievement. If a relationship is found between the two measures of learning rate, it would be anticipated that this would be a negative one since the rate measure, number of days to complete a unit, is the denominator for the rate measure of average daily achievement.

The results indicate that when these two measures are correlated, a moderately strong relationship exists in units of mathematics while only a moderate relationship is evident in units of reading. There is only one coefficient in mathematics, B-Addition, that is not significant from

zero and in reading all coefficients are significantly different from zero at least at the .05 level.

Therefore, because of this evidence of a significant relationship between the rate measure (1) number of days to complete a unit, and (2) the average daily achievement for both mathematics and reading null-hypotheses 21 and 22 can be rejected.

B. Conclusions

This study has examined several rather obvious measures of student rate of learning in the naturalistic setting of the classroom. From this study certain general conclusions can be formulated concerning the consistency of these rate measures and their relationship to selected student characteristics.

In examining the rate measures, number of days to complete a unit and average daily achievement, there is no general consistency of student rate of learning between topics of the same level of complexity, at different levels of complexity, or over a number of units. This would indicate that rate of student learning as measured in these ways is specific to a given task and not a general factor operating quite uniformly in all learning situations.

There was found to be no consistency of student learning rate between the curriculum areas of mathematics and reading for those rate measures pertaining to specific units. This would further support the general finding that rate of learning is specific to the task. An exception to this was found when the rate measure, number of units completed during one year, was studied in which a small but definite relationship was evidenced between the number of mathematic and reading units completed in one year.

The rate measures for specific units, number of days to complete a unit and average daily achievement, apparently are measuring something different from the rate measure number of units completed per year. It is possible that in considering the total number of units mastered in a year's time the difficulties specific to each individual unit are averaged out resulting in a more stable measure of learning rate. This averaging process could result in minimizing the error variance attributed to both the temporary and general characteristics and specific characteristics of the student.

There exists a definite relationship between the two measures of rate of learning for a particular unit which probably can be accounted for in terms of the manner in which each of the measures are determined. This relationship is further evidenced in examining the resulting data for both measures. There is a high degree of similarity when these measures are investigated in relationship to both student variables and consistency.

Therefore, in some cases, it would seem more economical to use the rate measure number of days required to complete the unit when essentially the same results are obtained as when using the more complex rate measure of average daily achievement.

Contrary to common belief there is little evidence to demonstrate any relationship between student intelligence and rate of learning measured in terms of the number of units completed in one year of study, number of days to complete a particular unit, or average daily achievement. Only the measure, number of units completed in one year of study, demonstrated even a minor degree of relationship between it and intelligence and then only in the curriculum area of mathematics. The rate measures, number of days to complete unit and average daily achievement, demonstrated that intelligence was in a few cases related to learning rate for specific units of study but was not found to be a general factor related to learning rate in all situations.

When student initial and final level of achievement are represented in terms of number of units, a moderate relationship between these measures and student intelligence is evidenced. This is interesting in view of the weak relationship that was demonstrated between number of units completed in one year and student intelligence. It would seem reasonable to assume that if there is a relationship between student intelligence and initial and final position in the curriculum, there would also be a relationship between intelligence and distance between these two positions. One possible explanation for this finding is that the type of study in which the pupils have been exposed in their previous years of schooling intelligence is an important determiner of how quickly a pupil masters content but that under Individually Prescribed Instruction many other factors tend to cancel out the importance of intelligence. This is in agreement with Deep's study in which he found that under a program of Individually Prescribed Instruction other factors besides intelligence are important determiners of achievement.[1] Of course it should also be recognized that number of units completed in one year is probably a much less reliable measure of achievement than number of units mastered over several years.

The student characteristic, level of reading achievement, is not in general related to either of the rate of learning measures for specific units but does demonstrate a moderate relationship with the rate measure, number of units completed during a period of one year of study, for the mathematics sequence. This relationship would be expected since intelligence was related to this rate measure and level of reading achievement and intelligence are highly related.

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[1] Donald Deep, "The Effect of an Individually Prescribed Instruction Program in Arithmetic on Pupils at Different Ability Levels," (unpublished Doctor's Dissertation, University of Pittsburgh, 1966), pp. 36-38.

C. Recommendations for Further Study

The focus of this study was to investigate three rather obvious measures of student rate of learning. These measures were studied in the context of the Individually Prescribed Instruction Project which involves a procedure that permits a student to progress through a series of learning experiences independently of other students. This study did not attempt to control for the wide range of student and task variables that impinge on the learning situation and undoubtedly influence rate. A logical extension of this study would be to investigate such variables as student transfer ability, amount of incidental learning, types of material employed, motivation, sequence of learning experience, and a host of other factors that could be important in determining rate of learning. Of particular importance is the diagnosing and prescription writing ability of the teacher. Even if a wide variety of appropriate learning experiences are available, if the teacher fails to make the proper diagnosis of the student's pre- and post-test results or writes an inappropriate prescription of learning experiences, there will be little if any individualization of instruction. The problem is deserving of a great amount of intensive study.

In view of the lack of consistency in the simple measures used in this research, it would seem to be appropriate to investigate a composite type of measure of student learning, such as that proposed in Carroll's[1] model, in order to account for the many factors that operate to affect rate of student learning. To develop this type of composite measure, it will be necessary to measure and to study a number of basic pupil variables. One such variable might be student motivation measured with respect to a specific learning task. For example, this could be studied in terms of how it combines with intelligence and other factors to influence rate. Other variables that probably should be studied in this way might include the student's physical and mental health, his self-dependence, his ability to comprehend directions, and similar factors that suggest themselves as having an influence on how quickly a student learns.

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[1] John B. Carroll, "A Model for Learning," Teachers College Record, LXIV, 1963, pp. 723-733.

In the pilot investigation of measures of rate of learning in the classroom represented by this study, the concern has been for examining the reliability or consistency of the raw measures of rate of learning that have been defined. It was felt that it was essential to investigate such measures at this point because of the fact that they are typically employed, even in an informal manner, in many considerations of the problems of instruction within the schools. However, it is recognized that further and more intensive investigations of rate measures should consider the the possibility of the need for deriving more ideal measures of rate through possible transformations of the type of raw indices used here. This would require a careful and intensive study and analysis of all of the distributions of the rate measures as revealed by the marginal distributions for the correlations reported in this study. This type of analysis was outside the scope and interest of the present investigation. However, it should be added, that in a limited examination of the effect of skewness in the distributions on the linearity of regression in the case of the correlations reported in this study, the writer did plot the relationships for several representative correlations and found little evidence of non-linear relationships.

Since the present study, along with others, suggests that rate of learning may be a function of the interaction between a student and the specific characteristics of given learning tasks or instructional materials, it would be interesting to identify some of the basic characteristics of such materials and to study their relationship to specified student variables. This type of information could be most useful in developing learning materials and in assigning the most effective materials to each student.

The analyses of rate of pupil progress that are being conducted as a part of the IPI project document the fact that under conditions which permit pupils to proceed at individual rates, pupils do vary greatly in the speed at which they progress through a learning sequence. It does not seem logical to assume that this variation is determined solely by chance. The present study has shown that rate is evidently quite complex in terms of the various factors that affect it. As school programs make increasing provision for individualized instruction and for variations in rate of learning an interesting challenge for educational researchers will be to identify the factors that serve to influence this variation.

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